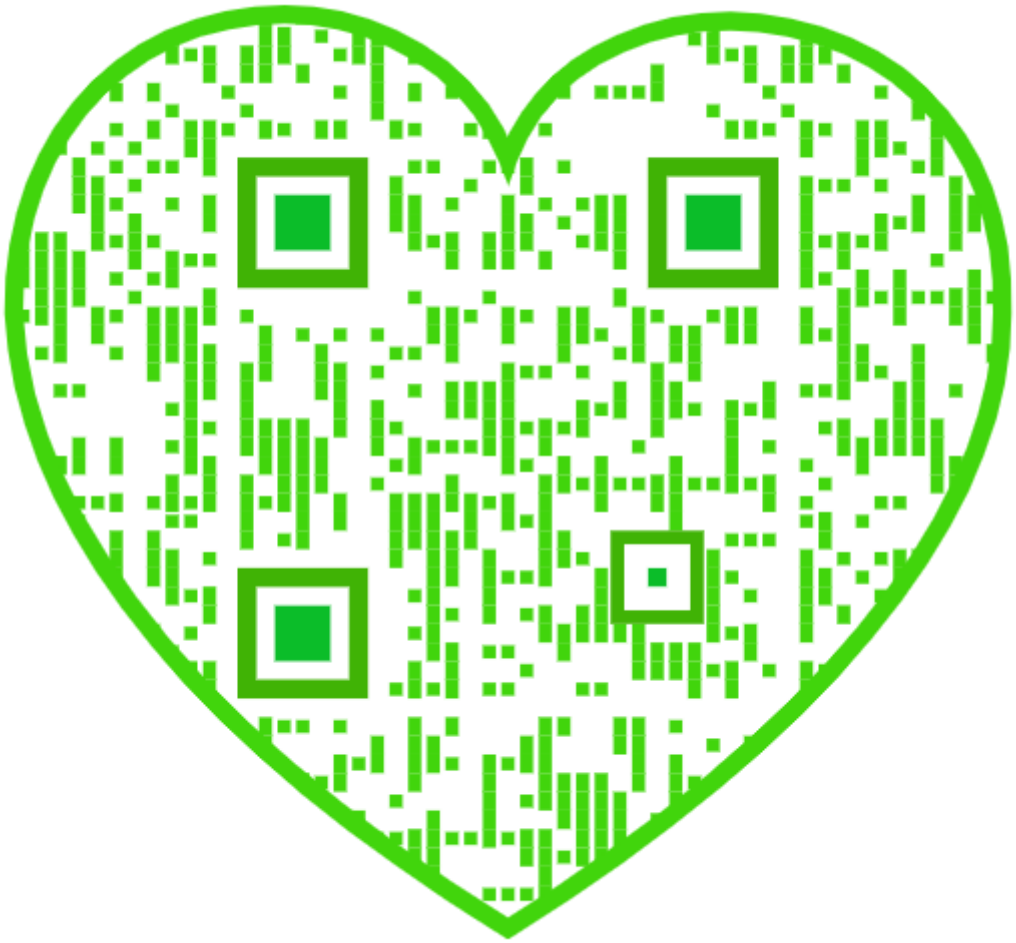
UNIVERSITY OF TORONTO
3 1761 00024716 3

FIFTY YEARS OF GLASS MAKING

1869 1919

PASC

TP
353
P6M3



This numbered copy 1280 of
FIFTY YEARS OF
GLASS MAKING
is presented to

M [illegible] Thiem

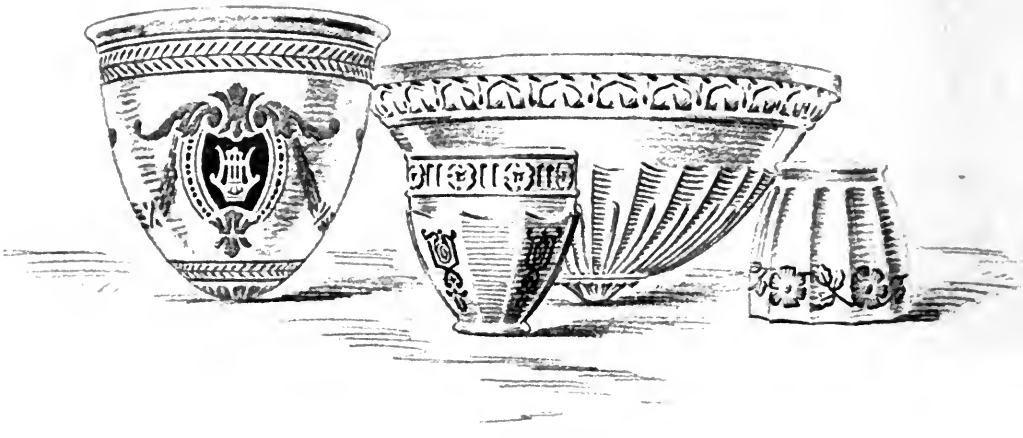
with the compliments of
Macbeth-Evans Glass Company
Pittsburgh

The Library
of the
David Dunlap Observatory

Presented by

Mr. T. L. Chant

Nov. 1, 1939



COPYRIGHT-1920
MACBETH-EVANS GLASS COMPANY
PITTSBURGH PA.

Geo. N. Macbeth

President 1899-1916

Thos Evans

President

HOWARD S. EVANS
Vice President

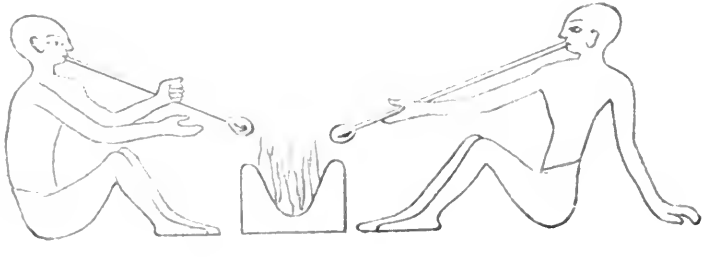
GEO. D. MACBETH
Secretary

FIFTY YEARS OF GLASS MAKING

1869-1919

TP
853
P6M3

HISTORICAL



GLASS has been traced by history and tradition to remote ages of the world. The time and place of its discovery will probably be never more than mere conjecture. Some writers would have us believe that "Tubal Cain," mentioned in Genesis 4:22 as "an instructor of every artificer in brass and iron," was the inventor. Doubtless this opinion finds its chief basis in the theory that glass, the offspring of fire, was discovered shortly after its progenitor.

Pliny, the Roman historian (23 A. D.—79 A. D.), wrote a somewhat different version of the discovery of glass. This ancient writer, in his story, declares that the discovery was accidental. "It is said," wrote Pliny, "that some Phoenician merchants, having landed on the coast of Palestine, near the mouth of the river Belus, were preparing for their repast, and, not finding any stones on which to place their pots, took some cakes of nitre (bicarbonate of soda) from their cargo for that purpose. The nitre being thus submitted to the action of fire with the sand on the shore, they together produced transparent streams of an unknown fluid, and such was the origin of glass."

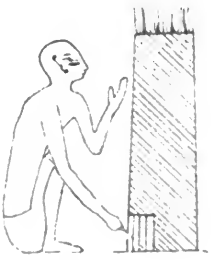


Figure 1

There are many who have taken exception to Pliny's account of the discovery of glass, declaring it impossible to produce glass in the open air and under the conditions described. However vague and indefinite the early history of glass may be, it is undoubtedly true that its

ancient discoverer, unknown and unheralded, gave the world one of its most important inventions. Destroy all glass, forget the methods of manufacture, and by that action you will sever the jugular vein of science, cripple the great industries and transform homes into dark, poorly lighted, unsanitary shelters reminiscent of the middle ages. The microscope, marvelous because of glass, would be valueless without it. The minute organisms, isolated under the skillful direction of the scientist, would continue to exist unseen. The telescope without its wonderful lenses would not reveal the universe filled with uncounted heavenly bodies, the knowledge of whose movements and characteristics enables the astronomer to forecast with uncanny precision natural phenomena.

The constantly increasing use of glass has made it indispensable in our domestic, scientific and industrial lives. In this book we shall attempt to trace briefly its development from known antiquity to present-day modern practice. The last fifty years have seen the greatest development in glass manufacture since its discovery. Processes have been marvelously improved. Intricate machinery has supplanted the slower, less accurate hand methods. Laboratories have eliminated to a great extent the element of chance, which, in earlier days, and even in this more enlightened period, has worked much havoc.

There are innumerable examples of glass, both in public and private collections, which are unquestionably of ancient origin, yet because of the lack of proper inscriptions it is impossible to classify them in chronological order.

The paintings of the Theban glassmakers reproduced herein were discovered on the tombs of Beni Hassan. These tombs, according to authentic records, were

Figure 2

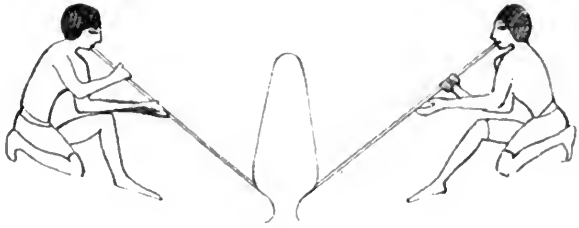


Figure 3

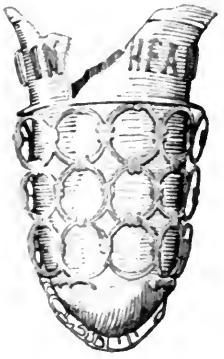
erected about 2000 B. C., but it is claimed that the paintings were executed during the Reign of Onsertasen I (3500 B. C.). Figure 1 represents an ancient Theban taking molten glass from the foot of a furnace. Figure 2 shows two others seated on the ground, holding pipes similar to those used at the present time. The glass on the end of the pipes, which are pointed toward the fire, is ready to be blown. Figure 3 illustrates the blowing of a large glass vase by two men.

Figure 4

The glass bead (Figure 4) found by Captain Hervey, of the Royal English Marines at Thebes, has inscribed on it in hieroglyphics the name of Queen Ramaka, for whom it was made. She was the wife of Thoutmes III of the eighteenth dynasty (1500 B. C.). We find it definitely established, therefore, that glass was being manufactured at Thebes at this early date, and it is quite evident that the industry was in more or less an advanced stage at that time.

When the Roman Emperor, Caesar Augustus, conquered Egypt (26 B. C.) he quickly recognized the commercial value of glass and ordered that it should form part of the tribute which he imposed upon the conquered country. This had the extraordinary and paradoxical effect of stimulating the Egyptian glass industry. The Romans, eager for novelty, bought

freely of the product of the Egyptian glassmakers, with the result that this industry flourished until the Reign of Tiberius (14 A. D.), when, according to Pliny, the Romans began the manufacture of glass in their own country. With characteristic intelligence and industry, they assimilated the knowledge of the Egyptians, and within a comparatively short time Roman glass rivaled that of Egyptian origin. Recognizing that the perpetuity of the industry depended upon widespread demand, glass was made into many dissimilar articles having broad application. Bottles, drinking glasses, vases and toilet articles, many of which bear a striking resemblance to those of the present day, were produced by these early Roman glassmakers.



Strassbourg Vase

When ancient Gaul fell under the yoke of the conquering Roman it was most natural that the art of glass making should be introduced into the new provinces. That the Gauls were adept students and later became in some respects superior to their Roman masters is evidenced by the works of art which have been unearthed in the ancient provinces of France. Probably the best example of the skill of these ancient Gallic glassmakers is the Strassbourg vase found in a coffin excavated by chance near the glacis of Strassbourg. It bears the name of Maximianu Herculius, a Roman emperor (250 A. D. —310 A. D.). The difficulties overcome in the manufacture of this vase clearly indicate that glass making was highly developed at this period.

When Rome and many of her provinces were overrun by the barbarous Huns, they ruthlessly devastated

and destroyed the industries of the conquered country, with the result that we find that glass making became a lost art in the West for several centuries.

Constantine the Great (274 A. D.—337 A. D.), when the glass industry died in the West, hastened to offer alluring inducements to the skilled workmen in that part of the world to come to Byzantium (Constantinople), the seat of his Empire. With the encouragement of Constantine, and also of Theodosius III, who reigned from 408 A. D. to 450 A. D., the manufacture of glass became an important industry. This monopoly of the East was not overcome by the West until the fourteenth century, when Venice became a factor. For several centuries the Venetian Republic maintained its leadership as the principal producer of glass. In order to more closely supervise the industry, to guard its secrets and to break the contact of the workmen with foreign countries, all the glass workers were confined to the Island of Murano, which is separated from Venice by a narrow strip of water. Marco Polo, in his travels in the Far East, discovered the rich markets of Tartary, India and China, where the natives were fond of false pearls and imitation gems. Venice quickly took advantage of these new markets, with the result that the city became wealthy because of its glass trade. The Germans, in spite of the attempted monopoly of the Venetians, began at this period to manufacture glass in their own country. Their product was heavy and ungraceful—in contrast with Venetian glass, which was noted for its fine and light filigree work and for its color. The German decorations were put

German Glass

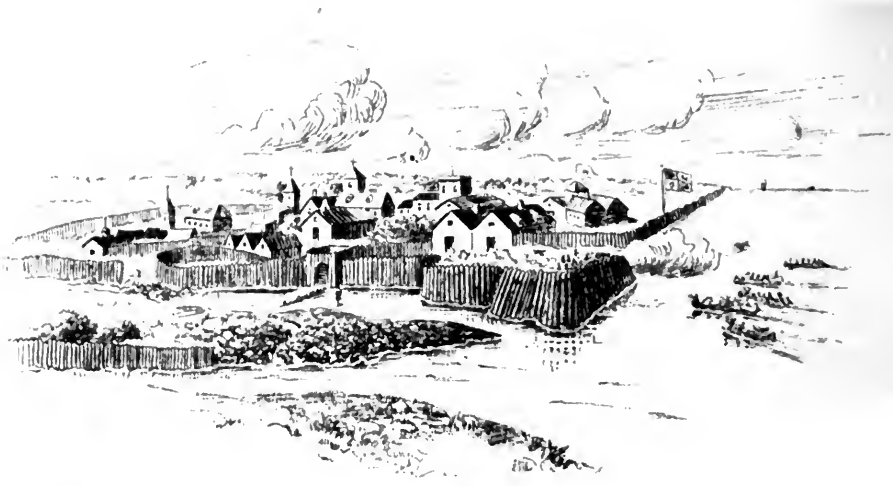
Venetian Glass

on with enamel and were, for the most part, reproductions of coats of arms. The German glassmakers of this time were responsible for many valuable formulas, among which was the one for making a beautiful ruby red, discovered in the early part of the seventeenth century.

Bohemia followed Germany closely in the establishment of her own glass works. It was not long, however, before the Bohemian manufacturers were making glass of a clearness superior to any previously manufactured. About 1609 Gaspar Lehmann, a Bohemian, invented a new method of decoration—that of engraving on glass. This new decoration revolutionized the industry, and while the Bohemian glass of this time was clear and light in weight, it unfortunately lacked brilliancy. It did, however, possess an originality which was not always in good taste but for which there was a demand because of its peculiar individuality.

England neglected the glass industry during the middle ages, and it was not until the Reign of Queen Elizabeth that glass was made in that country. This famous queen invited Cornelius de Lannoy to London for the purpose of establishing a glass works, and he was responsible for the first glass made in the British Isles.

Bohemian Glass



Harper's Encyclopedia of
United States History
Copyright, 1901, by Harper
& Brothers. All rights reserved.

JAMESTOWN IN 1622

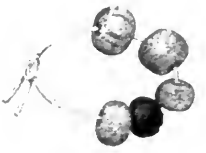
GLASS INDUSTRY IN AMERICA

GLASS making enjoys the distinction of being one of the earliest industries introduced in the new world.

In 1607 the first glass furnace was erected about a mile distant from Jamestown, Va. The product was confined to bottles. The second plant was erected in 1620 to manufacture glass beads, which were used extensively at that time in trading with the Indians. Both works were destroyed in the great massacre of 1622.

The next attempt to make glass in America was at Salem, Mass., where a plant was built in 1639 to produce bottles and other articles.

In Pennsylvania the first mention of glass making was found in a letter written by William Penn in August, 1683, to the Free Society of Traders. The location of the works and the product unfortunately were not disclosed.



Glass Beads Made at Jamestown, Va., 1621-1625

Two glass factories were in operation in New York

City in 1732. Seven years later the first glass works in New Jersey was built by Caspar Wistar about one mile east of Allowaystown, Salem County. In 1775 the failure of this enterprise resulted in the workmen moving to Glassboro, N. J., and establishing a new factory. The glass works now in operation in that city is a development from the factory built in 1775 and is one of the oldest continuously operated glass plants in America.

In the beginning of the nineteenth century, a number of glass factories had been erected throughout what is now the eastern part of the United States.

It was not long before the early American glass manufacturers discovered that it was important in the economic production of glass to locate in a section of the country which could, from its natural resources, furnish proper fuel. It was for this reason that Western Pennsylvania, and particularly the Pittsburgh district, showed such phenomenal growth as a glass center during the 19th century.

The celebrated American statesman, Albert Gallatin, has the distinction of establishing the first glass works in Western Pennsylvania. His plant was located about sixty miles above Pittsburgh on the Monongahela River and began in 1787 to manufacture window glass. In 1795 the first glass works was built in Pittsburgh and was known as "Scott's"—located on the south side of the Monongahela River. The product of this factory was chiefly window glass.

Stiegel Glass Tumbler

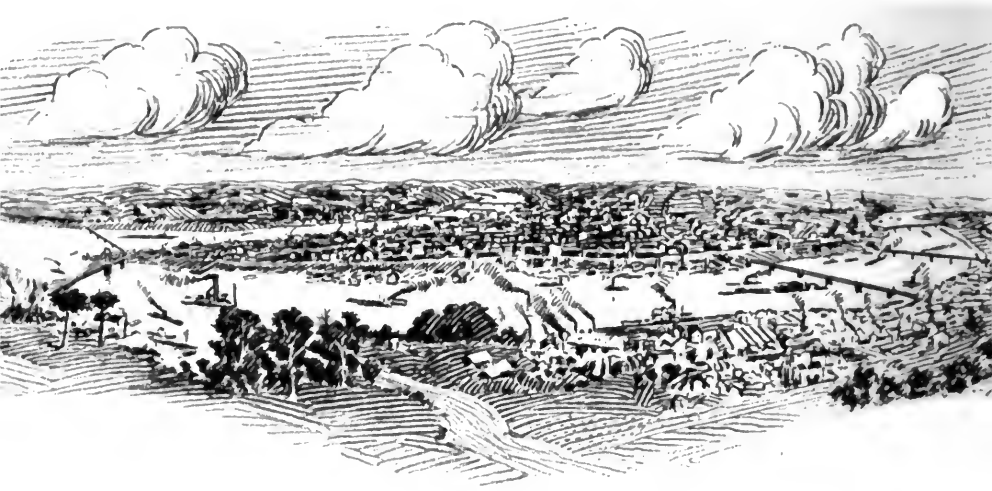
In 1797 General O'Hara and Major Craig erected a plant near

"Scott's." These men have been generally recognized as the pioneers in the glass industry in Pittsburgh. The success of O'Hara and Craig quickly attracted others, with the result that we find the glass industry in the Pittsburgh district in the first half of the nineteenth century showing a development clearly indicative of the ultimate dominating position of Pittsburgh as a glass center.

Molded Bottle
Early Nineteenth Century

In the period dating from the reconstruction days of the Civil War down to the present time the glass industry has undergone many revolutionary changes. No similar space of time in the history of glass making records the same number of epoch-making improvements in machinery and methods.

As in every great industry there are certain dominating influences which have contributed most to its advancement. Because of this fact, the history of the Macbeth-Evans Glass Company is interesting to the reader who knows in a general way that this company has been an important contributor to the advancement of the art of glass making during the time of its greatest development. It was with this fact in mind that the history of the Macbeth-Evans Glass Company has been written.



PITTSBURGH IN 1869

THE FOUNDERS

IN 1869, at the foot of Gist Street, in that part of Pittsburgh known as the Bluff, Thos. Evans established a glass works which marked the beginning of the Macbeth-Evans Glass Company. The plant was operated under the name of Reddick & Company.

In 1872, three years later, Geo. A. Macbeth, with several associates, purchased the Keystone Flint Glass Works, Second and Try Streets, Pittsburgh, known as the "Dolly Varden." The company operating the plant was called Muzzy & Company.

The melting equipment of the plant of Thos. Evans consisted of one ten-pot furnace, and the output was confined to handmade chimneys. A ten-pot furnace also completed the melting equipment of Geo. A. Macbeth's first glass works. The product, however, consisted of handmade chimneys, reflectors and lantern globes. Thus we find the beginnings of a great glass company like that of many of the world's greatest industrial institutions of today—modest, and for the most part financed by perseverance and courage.

Before tracing the development of each of these companies to the time when they were merged in 1899, forming the Macbeth-Evans Glass Company, it will be interesting to know something of the early careers of the founders.

George Alexander Macbeth

EO. A. MACBETH was born in Urbana, Ohio, October 29, 1845, the son of James Reed and Frances Ann Macbeth. Educated in the public schools of his native city, he moved at an early age to Springfield, Ohio. Here he secured employment in a retail drug store and it was while compounding prescriptions that he gained his first knowledge of chemistry, the study of which he continued unceasingly throughout his long and successful career.

Recognizing the limitations of the work in which he was engaged, Mr. Macbeth began to look for an opening which would give him an opportunity for greater development and ultimately more remuneration. It was not long after he had made up his mind to leave Springfield that fate opened the way for him to go either to Cincinnati or Pittsburgh, selling opportunities being offered him in these cities. In deciding to go to Pittsburgh, Geo. A. Macbeth disclosed some of the uncanny foresight which stood him in good stead in later years.

After coming to Pittsburgh he sold the products of B. F. Fahnestock Company, wholesale druggists; Armstrong Cork Company, manufacturers of cork products; W. H. Hamilton, bottle maker, and the Keystone Flint Glass Works, whose product was lead lamp chimneys. About 1872 the last named company became financially involved. With several associates Mr. Macbeth bought their plant, which was located at Second and Try Streets, and began the operation of this factory in 1872 under the name of Muzzy & Company.

This marked the beginning of the career of George Alexander Macbeth as a glass manufacturer. How successful he was is very fitly expressed in the following extract from the Proceedings of the Engineers Society of Western Pennsylvania, published after Mr. Macbeth's death on February 11, 1916:

"Geo. A. Macbeth had a good schooling experience at various institutions prior to his arrival in Pittsburgh in 1862 to engage in business. What difficulties he overcame and how, after 1862, he labored to perfect himself in his chosen field of glass making, we are not told, but we may be sure that it required an inflexible purpose and diligent effort on his part to emerge, as he did in 1872, as a glass manufacturer.

"Almost from the start he commenced those improvements in the composition and manipulation of glassware used for lighting purposes, which at once attracted attention and brought to his name a fame which spread all over the country and eventually reached all regions of the globe where American refined oils were used.

"When one thinks of this illimitable field of enterprise—true not monopolized by any one firm, but having regard to the commercial value of a name—there was here offered to Mr. Macbeth an opportunity for becoming the head of a legitimate trust of vast capitalization. With him, however, the advancement of personal wealth was secondary to his desire to explore ways for advancing knowledge in his chosen sphere. The inauguration of the Carnegie Institute in this city with its department of Science, Art and Literature brought together a group of the best equipped minds and the most noted scientific workers of western Pennsylvania. Mr. Macbeth was intimately associated with the men of this group and enjoyed their esteem, as he did also that of Mr. Carnegie, to the fullest extent. Besides Mr. Macbeth's interest in applied science, he was an authority and critic of no mean rank on etchings and engravings. He was very active in bringing about the vast extension of the great building and especially the enlargement of the library and the establishment of its branches throughout the city."

Thomas Evans

THOS. EVANS was born in Pittsburgh, on October 5, 1842, the son of Evan and Eleanor Jones Evans. His father and mother had come to the United States from Wales in 1835 and settled at Ebensburg, Pa., moving a few years later to Pittsburgh, where Thos. Evans was born. He was one of a family of six. In 1856 his father, who was employed as a mechanic in the glass works of Bakewell, Pears & Company, was killed in a fly-wheel accident. Thos. Evans, who was thirteen years old at the time, was compelled to leave school and accept with his brothers the responsibility of providing for the family. His mother having died seven years before his father made the task all the greater. With characteristic courage, however, he assumed the burden which fell upon his youthful shoulders.

His first position was with Bakewell, Pears & Company, where he was employed as an errand boy at a salary of $6.00 per month. He took up his duties on Wednesday, and on Saturday he received his first pay, which consisted of one gold dollar. He has often said that he has not seen a dollar since quite as large as that one.

He continued in the employ of Bakewell, Pears & Company until 1862, when he became associated as a salesman with William N. Ogden & Company, dealers in oil and lamp chimneys, located at Liberty and Wood Streets. In 1863 he went to Cleveland, Ohio, where he remained for one year, during which time he was employed as a salesman by S. S. Barrie & Company,

large retailers of oil lamps and glassware. Returning to Pittsburgh he was successively employed by Wallace & Company, who had a retail store on Wood Street, and Atterbury & Company, large glass manufacturers at that time. Just previous to the organization of his own company in 1869 he was with Fry, Semple & Reynolds, who operated a glass plant at the foot of Seventeenth Street on the South Side. The diversified experience which he gained in being associated with both the retail and manufacturing branches of the glass industry provided him with the foundation upon which his later career was built.

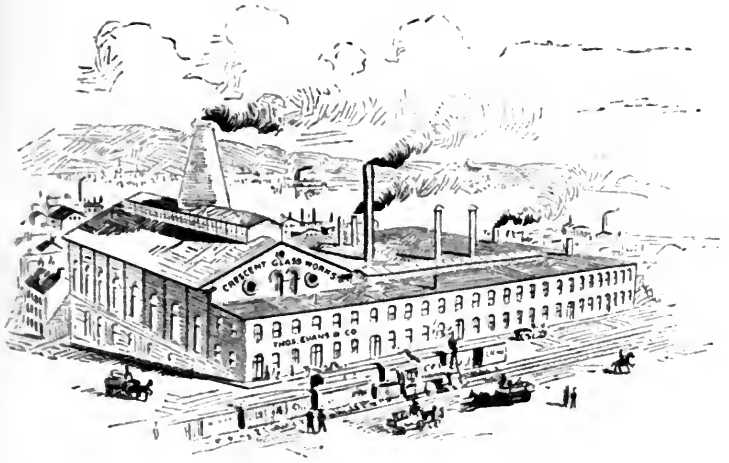
Those who have been associated with Thos. Evans over a long period of time can best appreciate the sterling qualities which eventually brought him recognition as one of the outstanding figures in the glass industry in America.

The history of the Macbeth-Evans Glass Company and of Mr. Evans's earlier venture in glass making reveals to only a small extent his genius for organization and finance. His has always been an indomitable will plus a high type of courage, primary essentials in the pioneer days of his career, and contributing factors to the success of Macbeth-Evans Glass Company, of which he was treasurer from 1899 to 1916, when he became president.

Development of the Thomas Evans Company

EDDICK & COMPANY, organized in 1869 by Thos. Evans, was capitalized at $14,000.00, the stock being owned by Thos. Evans, James Reddick and fifteen skilled glass workers. After operating for three years, it developed that the continued existence of the company necessitated the removal of the works to the south side of the Monongahela River. This was because the more favorable labor conditions in that section made it possible to operate a glass plant with greater economy.

After a thorough canvass of the situation, Mr. Evans found that the works of Fahnestock, Fortune & Company, located at Josephine and Twenty-second Streets, could be purchased for $35,000.00. A glimpse of the courage of this man is revealed in the fact that but $5,000.00 was paid in cash, the balance being represented by notes. It was a noteworthy transaction and, because of the lack of money, extremely difficult to handle. The fact that Thos. Evans was barely thirty years of age at the time he negotiated this deal shows that his genius for organization and finance was developed at an early date. The new plant was the largest lamp chimney factory in Pittsburgh, operating sixty shops.



Works at 18th and Josephine Sts., Thos. Evans & Co.

In 1873 James Reddick retired and the name of the company was changed to Evans, Sell & Company. In 1877 a machine known as the "Patent Crimper" was invented. The introduction of this machine had the immediate effect of greatly increasing production and reducing costs correspondingly. Quickly recognizing the necessity of having this machine in his factory in order to meet competition, Mr. Evans secured a license to use the "Patent Crimper." The workmen were not in sympathy with any improvement tending toward the increase of production, laboring under the delusion that it would result in fewer employees as well as less work. The conditions outlined by the workers under which they would operate the machine were so unreasonable that they could not be accepted. The men quit work and very quickly a general strike spread through all the factories operating patent

Employees of the 18th St. Works, Thos. Evans & Co.

crimping machines. The fifteen glass workers who owned stock in Evans, Sell & Company refused to work, thus creating an unpleasant situation. Mr. Evans made a proposition to them for the purchase of their interests, which was accepted. The firm name was then changed to Evans & Company. Because of the determined stand taken by the workmen, it was evident that the strike would be of long duration. What to do under the circumstances was a problem. With his characteristic ability to think straight and decide promptly, Mr. Evans determined to secure a factory in another city which could be operated temporarily and thus maintain the identity of his company with the trade during the time his Pittsburgh plant was closed. A careful search disclosed an idle glass works in the northwestern part of Chicago. Leasing this plant he secured workmen from widely separated sections of the country and within a short time had the factory in operation. Desperate attempts were made to prevent the operation of the works, but in spite of the great difficulties encountered, Mr. Evans, although his life was in danger almost constantly, kept the plant going

for about one year, when the strikers made overtures looking toward a settlement. After several conferences a compromise was effected, the result of which was the immediate abandonment of the Chicago works and the resumption of operations at the Pittsburgh factory.

In 1881 Mr. Evans sold his interest in the company and erected in the same year a plant at Josephine and Eighteenth Streets, operating under the name of Thos. Evans & Co. The melting equipment of the new factory consisted of a large fifteen-pot furnace. The business grew so rapidly that in order to meet the demand for his product Mr. Evans leased the factory owned at one time by his former employers, Frye, Semple & Reynolds, located at the foot of Seventeenth Street on the South Side. In 1887 the Thos. Evans Company was incorporated.

In 1890 the development of the natural gas field in Indiana gave the glass manufacturers an opportunity to obtain fuel at small cost, and many factories removed to that section. To meet the competition of these plants, Mr. Evans in 1892 established a works near Marion, Indiana. The new plant contained three fifteen-pot furnaces. Coincident with the opening of the Marion works, the Seventeenth Street factory was discontinued. Forty-five pots at Marion and fifteen pots in operation at the plant on Eighteenth Street, Pittsburgh, making a total of sixty pots, made the Thos. Evans Company the largest lamp chimney manufacturers in the world.

The production of the Thos. Evans Company reached the enormous total at that time of 12,000,000 lamp chimneys a year. The factories of the company produced in addition to lamp chimneys large quantities of lantern globes and oil lamp shades as well as other illuminating glass. One historian of the time visualized

Group of Employees of the Thos. Evans Company

the output of the Thos. Evans Company in the statement that the production laid in line would reach 1500 miles—built up as a ten-foot hollow square it would form a chimney over nine miles high.

The use of colored decorations in the forms of wreaths, flowers, landscapes and marine views on lamp chimneys and shades became popular about 1885. The demand for these decorated chimneys became so widespread that within a comparatively short time the Thos. Evans Company were decorating 4,000,000 chimneys and shades a year, employing seventy-five to a hundred women for this work alone.

The Thos. Evans Company continued to maintain its leadership as the largest lamp chimney manufacturers in the world until 1899, when it was combined with the Geo. A. Macbeth Company, forming the Macbeth-Evans Glass Company.

Development of the George A. Macbeth Company

THE melting equipment of Muzzy & Company organized by Geo. A. Macbeth in 1872 consisted of a ten-pot furnace. The employees numbered about 150. The plant was generally known throughout the glass industry by the nickname "Dolly Varden."

In 1880 the factory of Atterbury & Company, known as the "White House" and located at Tenth and Carson Streets, South Side, was leased and operated by Mr. Macbeth under the name Geo. A. Macbeth & Company. The output, which was confined to lead glass chimneys, reflectors and lantern globes, was melted in a ten-pot furnace.

In 1881 Muzzy & Company, operating the Keystone Flint Glass Works, and Geo. A. Macbeth & Company were absorbed in a corporation which was called the Geo. A. Macbeth Company. The principal owners were Geo. A. Macbeth, Harry Darlington, W. G. Muzzy and C. Z. F. Rott. Coincident with the formation of the new company, the plant at Second and Try Streets was abandoned.

In 1882 the Geo. A. Macbeth Company, in the plant at Tenth and Carson Streets, built a fourteen-pot

"White House" Employees, Geo. A. Macbeth Company

"Deep Eye" furnace, the largest melting unit of its kind in the United States at that time. After the completion of this furnace this company began the manufacture of colored lantern globes, signal glasses, lenses and roundels, for railroad and marine use. It was in the making of these products that Mr. Macbeth gave expression to his unceasing study of glass chemistry and his desire to reach ultimately the position of being able to manufacture everything for industrial, scientific and illuminating purposes.

In 1886 a factory located at Eighth and Sarah Streets was purchased from Adams & Company. The melting capacity of this plant was limited to a ten-pot furnace and its product was confined to lead glass chimneys.

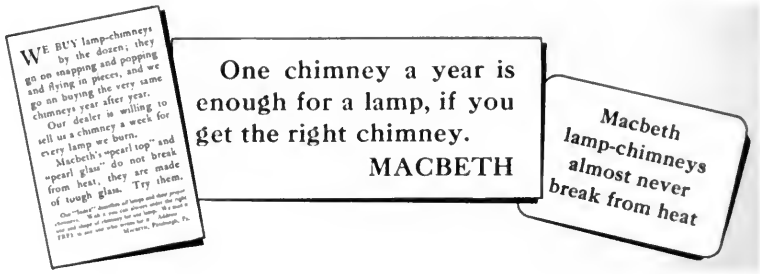
In the year 1883 Mr. Macbeth secured the design patent under which he manufactured chimneys which he marketed as "Pearl Top." This patent covered the decoration consisting of thirty-six beads or pearls around the top of the Number 1 chimney and forty

beads or pearls on the Number 2 chimney. "Pearl Top" chimneys continue to be manufactured that way to this day.

Mr. Macbeth's merchandising instinct quickly recognized the possibilities of trade-marking and advertising these chimneys. He engaged the services of an advertising agency in St. Louis and during the first year his appropriation totaled $25,000.00. Compared to the mammoth advertising appropriations of the present day, this amount seems insignificant. In those early pioneer times when advertising was frowned upon by many of the old-established companies who believed it to be an instrument employed chiefly to exploit patent medicines and fake schemes, the spending of this amount of money to advertise a lamp chimney was exceptionally daring and a decided deviation from the ordinary selling methods. There were many who believed that it would ultimately ruin his business, but notwithstanding the criticism of his friends and competitors, the advertising was continued year after year with splendid results.

In 1886 Mr. Macbeth engaged the services of John E. Powers, who was the outstanding figure in the advertising world at that time. Working together, these two men outlined an advertising and selling campaign for "Pearl Top" and "Pearl Glass" lamp chimneys which made these chimneys famous the world over. The unusual copy used in the advertisements created widespread comment. Particularly was this true of the car cards used in the New York Elevated Railroads. These were always placed at the end of the car where they were easily seen. Some of the early advertisements are reproduced on the following page.

In 1890, wishing to take advantage of the cheap fuel available because of the gas development in Indiana,


WE BUY lamp-chimneys by the dozen; they go on snapping and popping and flying in pieces, and we go on buying the very same chimneys year after year.
Our dealer is willing to sell us a chimney a week for every lamp we burn.
Macbeth's "pearl top" and "pearl glass" do not break from heat, they are made of tough glass. Try them.
One chimney a year is enough for a lamp, if you get the right chimney.
MACBETH
Macbeth lamp-chimneys almost never break from heat

a factory was built at Elwood, Indiana. Two fifteen-pot furnaces completed the melting capacity and the product consisted of paste mold lead lamp chimneys. It was in the Elwood plant in 1891 that optical glass was first successfully produced in the United States. This was a signal triumph and was accomplished in spite of the doubts of the instrument makers and other users that optical glass equal in quality to the imported could be made in America. A one-pot furnace for melting the glass was built and skilled workmen were secured at great expense. Optical glass of excellent quality was produced, but unfortunately labor in foreign countries was so much cheaper that it was impossible to compete with the imported glass inasmuch as most of it came in duty free or nearly so. In addition, the American instrument makers agreed among themselves to buy only foreign glass. The folly of refusing protection to this industry was demonstrated during the late war, when frantic attempts were made to make optical glass. Had the industry been fostered, there would have been plenty of optical glass for the instruments used by the army and navy.

After losing three sets of six-inch lenses which he was making for the Tokio Observatory at Tokio, Japan, during the grinding process, Dr. John A. Brashear appealed to Mr. Macbeth for assistance. Optical glass made at the Elwood plant of the Geo. A. Macbeth Company was sent to Dr. Brashear, and from it the

Employees at the "White House," Geo. A. Macbeth Co.

lenses now used in Tokio Observatory were ground and polished.

The high quality of the products of the Geo. A. Macbeth Company was recognized at the International Exhibition at Philadelphia in 1876, the Exposition Universelle in 1889 at Paris, France, and at the Columbian Exposition at Chicago in 1892. Reproductions of the certificates awarded to the Geo. A. Macbeth Company are shown on page 44.

In 1894 two fourteen-pot furnaces were added to the melting equipment of the plant at Charleroi, Pa. The factory known as the "White House" at South Tenth and Carson Streets was abandoned in 1895, leaving three plants operated by the Geo. A. Macbeth Company: Charleroi, Pa.; Elwood, Ind., and the factory at Eighth and Sarah Streets, South Side, Pittsburgh, Pa. These factories were in operation at the time of the formation of the Macbeth-Evans Glass Company and were taken over by the new corporation.

These plants are still operated with the exception of the factory located at Eighth and Sarah Streets, which was sold in 1920. The disposal of this works marked the passing of one of the historical glass plants of the South Side of Pittsburgh.

Macbeth-Evans Glass Company

Pittsburgh, Pa.

INCORPORATED - 1899

Macbeth-Evans Glass Company

IT is generally conceded that the two most powerful influences giving the greatest impetus to the manufacture of glass during the last fifty years were (1) the substitution of gas for coal and (2) the invention of the glass-blowing machine.

When coal was used for fuel it gave off sulphur fumes which destroyed the brilliancy of the glass. This defect was overcome by the use of gas, with the result that we find a contemporary writer stating that the new fuel will "cause ultimately Pittsburgh glass to surpass the wonders of old Venice and the Bohemian's best work." The second influence, the invention of the glass-blowing machine by M. J. Owens, of Toledo, Ohio, made it possible to increase the production of lamp chimneys and other articles many fold over what could be made by hand. The patent on this machine was owned by the Toledo Glass Company, which operated a factory at Toledo, Ohio, under the name of the American Lamp Chimney Company. It can readily be seen that the invention of this machine would cause much concern on the part of glass manufacturers inasmuch as it was not possible to compete with it successfully.

Realizing that the continued existence of their respective companies depended upon securing the ownership of this patent, Mr. Thomas Evans and Mr. George A. Macbeth in 1899 formed the Macbeth-Evans Glass Company, which in turn absorbed the American Lamp Chimney Company, taking over the patents on the Owens glass-blowing machine. The

President's Office

Directors' Room

General Office

Reception
Hall

new company was capitalized at $2,000,000.00. This was probably the largest single transaction which had taken place in the glass industry in America up to that time.

Shortly after the incorporation of the new company, the Hogan-Evans Company, whose plant was located at Twenty-second and Josephine Streets, was purchased. The Geo. A. Macbeth Company, at the time of the merger, operated a factory at Charleroi, Pa., containing three twelve-pot furnaces and a plant at Elwood, Indiana, which had two fifteen-pot furnaces and one twelve-pot furnace. A third plant located in Pittsburgh operated one twelve-pot furnace, making a total in all of ninety pots.

The Thomas Evans Company at this time was operating one fifteen-pot furnace in the plant at Eighteenth and Josephine Streets, Pittsburgh; three fifteen-pot furnaces in the factory at Marion, Indiana, and two ten-pot furnaces in the Seventeenth Street Works, making a total of eighty pots. Immediately after the Owens patent was acquired together with the American Lamp Chimney Company, whose capacity was limited to one sixteen-pot furnace and one fourteen-pot furnace, the Seventeenth Street Works was abandoned, making the total of 180 pots as the capacity of the Macbeth-Evans Glass Company at the time that it really began operation. Shortly after the company was formed a continuous tank with a working capacity equivalent to thirty pots was built at Charleroi Works. In 1902 the fourth furnace was built in the same factory. When this furnace was completed the Macbeth-Evans Glass Company began the manufacture of all kinds of glass for illumination.

The most important feature in connection with the formation of the Macbeth-Evans Glass Company, aside

Display Room

Technical Display Room

from the purchase of the Owens glass-blowing machine, was the bringing together of Mr. George A. Macbeth and Mr. Thos. Evans, one the antithesis of the other in many respects, but both well grounded in the intricate processes of glass making. The first, a man of great imagination; the second, more conservative but admirably fitted by reason of a keen business instinct and a thorough knowledge of glass making to direct the financial destiny of the new company, an exceedingly difficult and important task, as later years disclosed.

The Macbeth-Evans Glass Company, under the guidance of these two men, grew so rapidly that it soon outdistanced its competitors in the majority of the lines manufactured. The works at Bethevan, Ind. (changed from Marion, Ind.); Elwood, Ind., and Toledo, Ohio, have been extended and improved by the introduction of labor-saving machinery, since they first became part of the Macbeth-Evans Glass Company.

It has been the Charleroi Works, located at Charleroi, Pa., about 40 miles distant from Pittsburgh, that has had the greatest growth. This plant, including the Hamilton plant acquired in 1918, covers 21 acres, and has a melting capacity of 63 pots, 2 continuous tanks, and 15 day tanks. Combined with this melting capacity is the large accessory equipment necessary for the efficient production of glass in large volume as well as that needed in the manufacture of glass of special nature.

The Charleroi Works has been responsible for many of the extraordinary accomplishments of the past twenty years in the glass industry. Some of these are described in the chapter reviewing the products of this company.

THE UNITED STATES OF AMERICA
REPUBLIQUE FRANÇAISE
EXPOSITION UNIVERSELLE DE 1889
ETATS-UNIS
INTERNATIONAL EXHIBITION
1876
CERTIFICATE OF AWARD
Keystone Flint Glass Manufacturing Co
LAMP GLASSES

Staff Organization and Its Development

WHEN the Macbeth-Evans Glass Company was incorporated in 1899, the separate organizations of the Thos. Evans Company and the Geo. A. Macbeth Company were combined. The general office of the new organization was established in the Bell Telephone Building on Seventh Avenue, Pittsburgh. As in every corporation, a board of directors was the governing body. The active direction of the Manufacturing and Sales Department was directly under the supervision of Geo. A. Macbeth, President, and Thos. Evans, Secretary and Treasurer.

The comparatively simple organization at that time has developed due to the rapid growth of the business into the highly specialized company of the present day. It would be tiresome to trace the various changes which have taken place during the past twenty years, but it undoubtedly will be of interest to describe the organization as it exists today.

The operations of the company are divided into the following principal departments: Executive, Manufacturing, Research, Purchasing, Sales, Advertising, Accounting, Credit, Traffic and Engineering, each with a head responsible to the Executive Department. Finance is not represented, as it is under the direct control of the Executive Department.

The Export Department is located in New York City. Through this department and its representatives

Chemical Laboratory

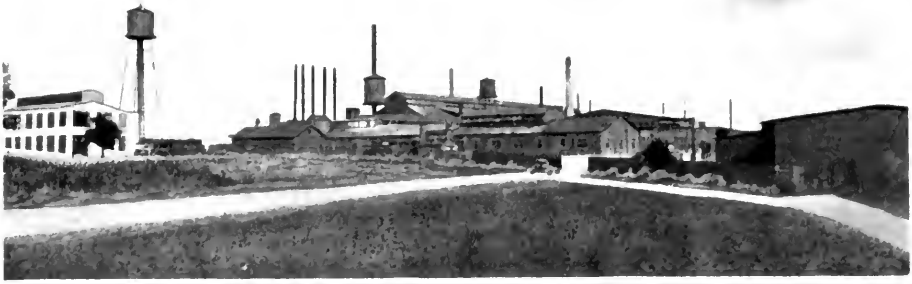
Physical Laboratory

throughout the world, the products of the Macbeth-Evans Glass Company are distributed to foreign countries, some of them being shipped to the most remote parts of the globe.

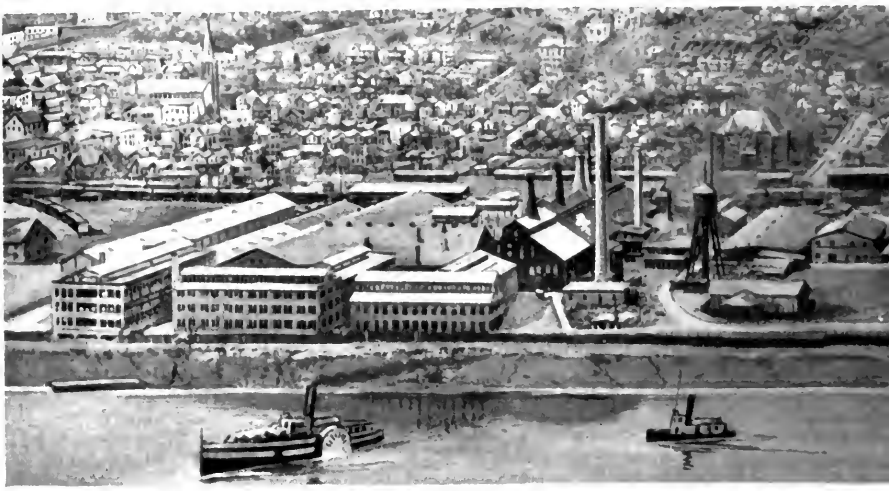
Weekly meetings of the various department heads are held, at which increasing problems of operation are discussed and solved. The co-ordination of the various departments is under the direction of the Assistant Secretary. While the work which the Research Department is doing has always been carried on to a certain extent, the highly specialized organization of today was not dreamed of a few years ago. In its well-equipped laboratories, its chemists, physicists and ceramists, under the supervision of an able director, have eliminated to a very large extent the element of chance which has made the glass industry so hazardous. It is in the Research Department that the increasing number of glass problems, presented by the widely diversified industries of the world, are studied and solved.

The operation of all works is under the supervision of the Manufacturing Department, directed by a committee consisting of a General Manager and two Assistant General Managers. Works superintendents are directly responsible to this committee. In addition, this committee has to do with the company's relations to its workmen, their employment, efficiency, welfare, compensation for accidents, and with other duties of similar character. That the welfare of the workmen is carefully considered is evidenced by the establishment of a cafeteria a few months ago at Bethevan plant, at which the employees can secure their noon-day lunch at cost.

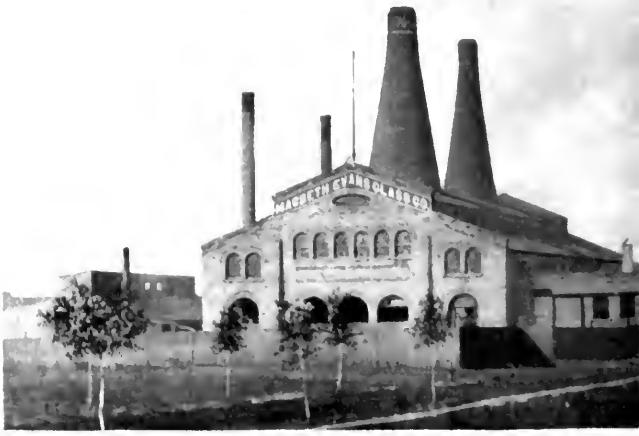
Quite recently the life of every employee was insured under the "Group" plan as it is generally known. All this expense is borne by the company—the amount of each policy being dependent upon the salary and the length of service of the employee.



BETHEVAN WORKS BETHEVAN INDIANA



CHARLEROI WORKS



TOLEDO WORK

ELWOOD WORKS ELWOOD INDIANA

LEROI PENNSYLVANIA

TOLEDO OHIO

New York Office

Chicago Office

Macbeth-Evans Glass Company, Ltd.
Toronto, Canada

San Francisco Office

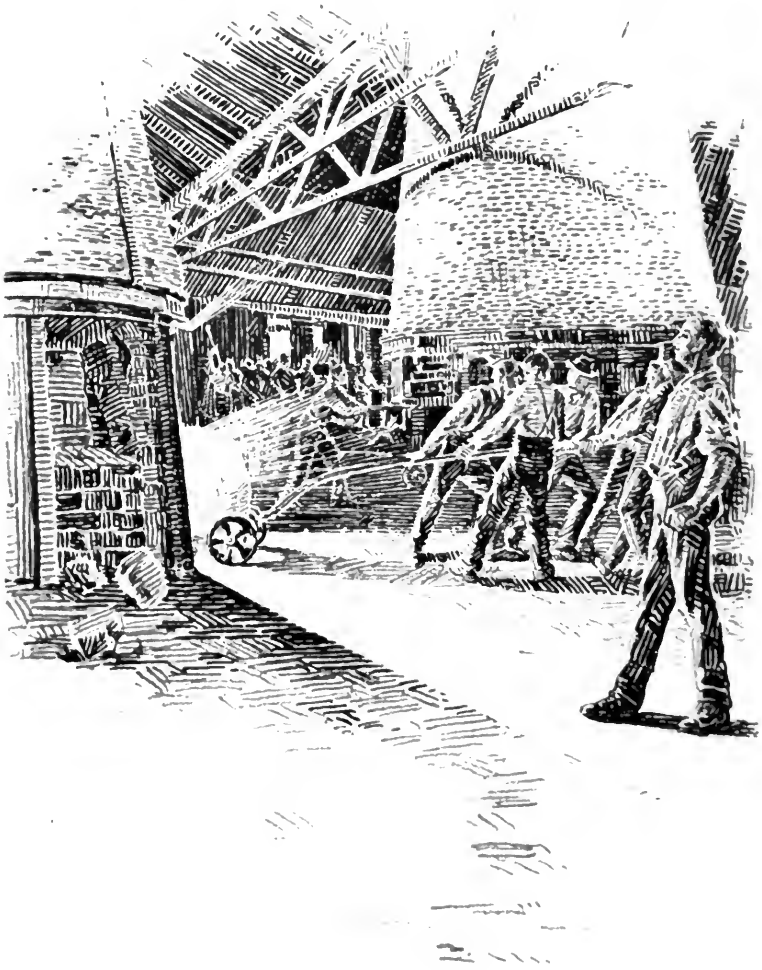
Boston Office

Philadelphia Office

Cafeteria—Bethevan Works

Cafeteria—Bethevan Works

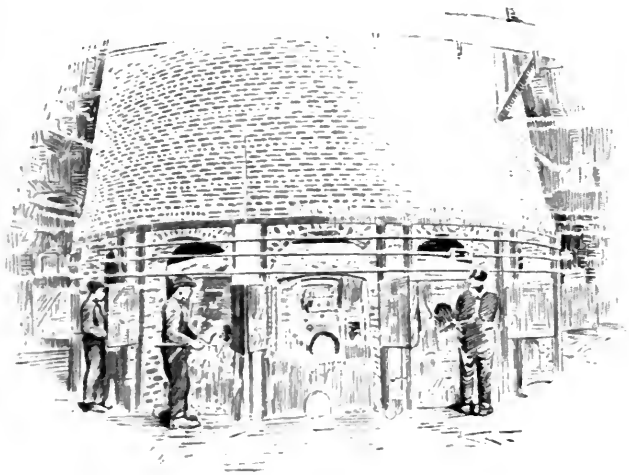
GLASS MAKING



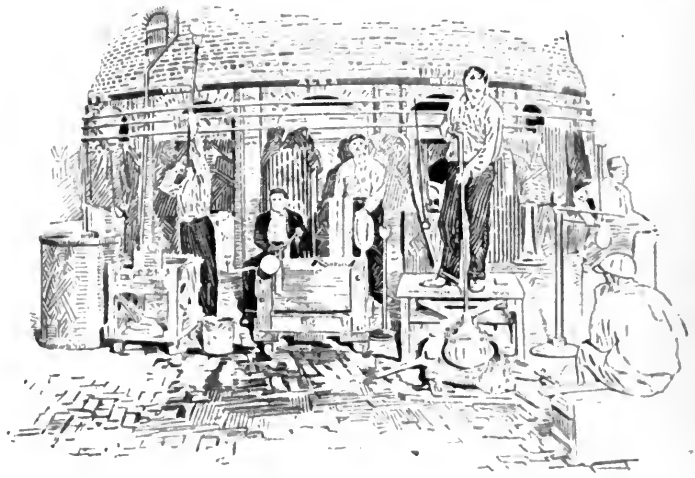
TO the uninitiated the manufacture of glass has about it a halo of mystery. This can be attributed, partially at least, to the fact that the materials which compose it are opaque. The resulting product—glass—is usually thought of as transparent, notwithstanding the fact that glass is made in various degrees of opacity. The mysterious agent which causes this transformation is fire.

Since the first glass was made, the two essential ingredients have been silica in the form of sand and alkali. In commercial glass of the present day, a metal such as lead, zinc or aluminum forms the third ingredient.

The glass industry depends upon natural deposits of sodium and potassium. The principal ingredients of nearly all modern glass are sand, soda-ash, potash, lime, borax and lead.



Pot Furnace



A "Shop" Making Blown Ware

Sand, which comprises 50 to 75 per cent of the mixture or batch as it is called, which is melted to form glass, is found in practically pure form in various parts of the United States. Notwithstanding this fact, however, it is necessary to wash all sand in order to remove any foreign substances which may be present, chief among which is alumina.

Soda ash (sodium carbonate) is used as a flux. Its substitution for potash reduces the melting point of the batch considerably below that in which the same quantity of potash has been used. The chief reason, however, for using soda ash instead of potash is because it is less expensive.

Lime (calcium carbonate) is used principally to harden glass, and at the same time, facilitate melting and refining.

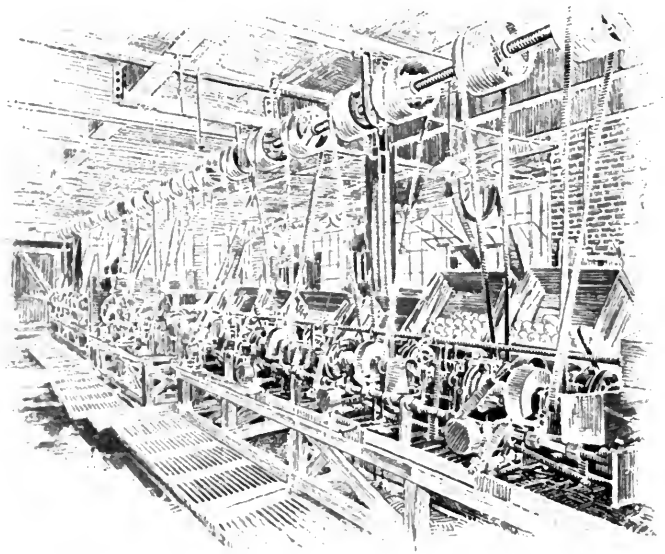
Potassium, in the form of pearlash or potash, like soda, acts as a flux. It is more expensive than soda

and for that reason is used only in those glasses where high brilliancy is required.

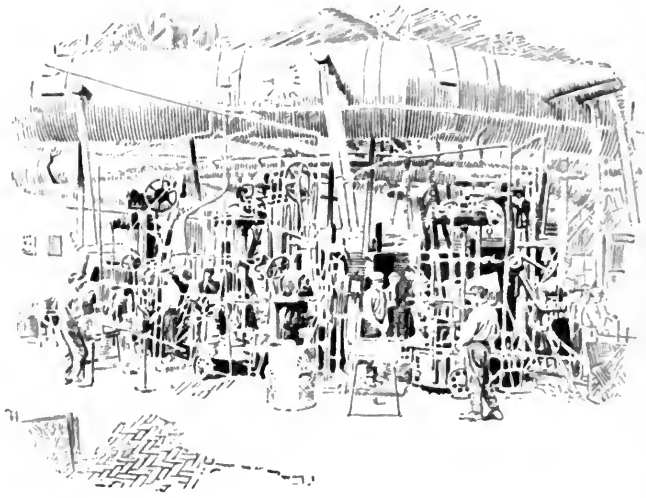
Nitre and borax are alkalies which are frequently used because of the large amount of oxygen which they contain. Glass in which alkalies have been used to excess, when exposed to the chemical action of the atmosphere and moisture, takes on an iridescent appearance, and in many cases this "soft glass" if stored away for a time will have its entire surface covered by a white film.

Lead is the principal metallic ingredient and is used either in the form of litharge or red lead. Lead increases the brilliancy of glass and makes it heat resistant.

Aluminum, arsenic, zinc, tin, barium, antimony and many of the rarer elements are now used in glasses manufactured to meet special requirements.



Grinding and Polishing Department



Making Glass with Machinery

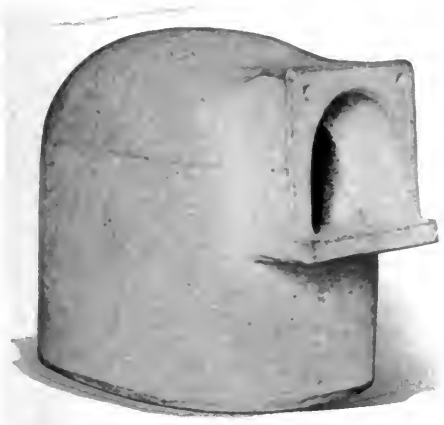
Colored Glass

One of the most difficult problems in glass manufacture is the control of color in glass. Metallic oxides are generally used and while certain elements produce a definite color, such as the blue of cobalt, yet the varying conditions entering into the manufacture of glass frequently result in the same element producing different colors.

It is interesting to note here, however, that the development of highly organized laboratories in the plants of a few glass manufacturers is, to a large extent, bringing under control the vagaries of the batch in its transition from the raw mixture into molten glass.

Melting

The batch, after the raw materials have been carefully mixed, is melted either in a pot or a tank, at a temper-



Clay Pot

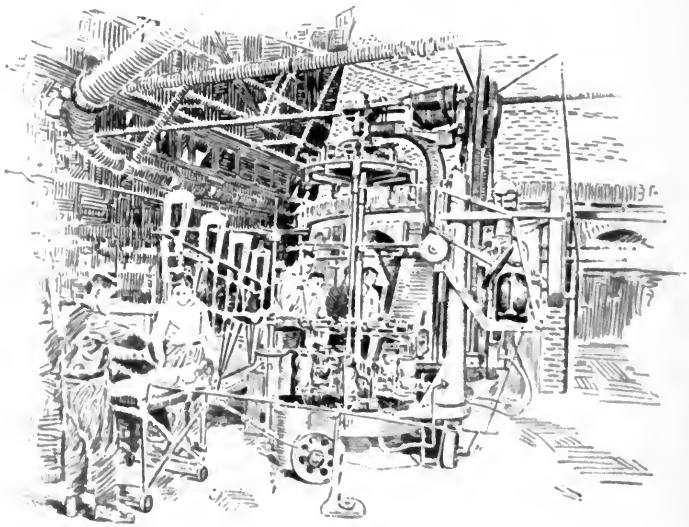
ature of approximately 2600° Fahrenheit.

Except in the manufacture of optical glass, in which one pot is used in a furnace, the number of pots to a furnace will range from six to twenty. A pot furnace is ordinarily conical in shape, tapering toward the top and extending well above the roof of the building. At the base of the furnace is the fire, above which the pots are arranged before arched openings. The fire by forced draft envelops the pots, melting and refining the batch. The time required is dependent upon the kind of glass which is being made. The pots are filled and the molten glass gathered through a projecting aperture extending to the furnace wall.

The material used in the manufacture of pots from time immemorial has been fire clay. It is absolutely essential that this clay be as homogeneous as possible. The making of a pot is necessarily a long and tedious process, requiring great care, as obviously a defective pot may mean the loss of a valuable batch.

The present day tendency in plants of large production is toward an increasing use of the tank furnace, of which there are two kinds—a day or intermittent tank and a continuous tank. The former is nothing more than a large rectangular pot where the batch is charged, melted and gathered in much the same way as when a regular pot is used. A continuous tank furnace, on the other hand, is one so constructed as to melt glass

by a continuous process. It consists of two principal divisions, a charging and melting "End" and a refining or working "End," connected by a restricted passage called the throat. The capacity of these furnaces varies from one hundred to seven hundred and fifty tons of molten glass. Glass batch and cullet are fed at short intervals into the charging end of the furnace and are there melted. The molten glass then passes through the throat of the furnace into the refining end and gradually flows toward the various points at which it is gathered or otherwise removed.



Making Lamp Chimneys with Machine

Molds Used in Glass Making

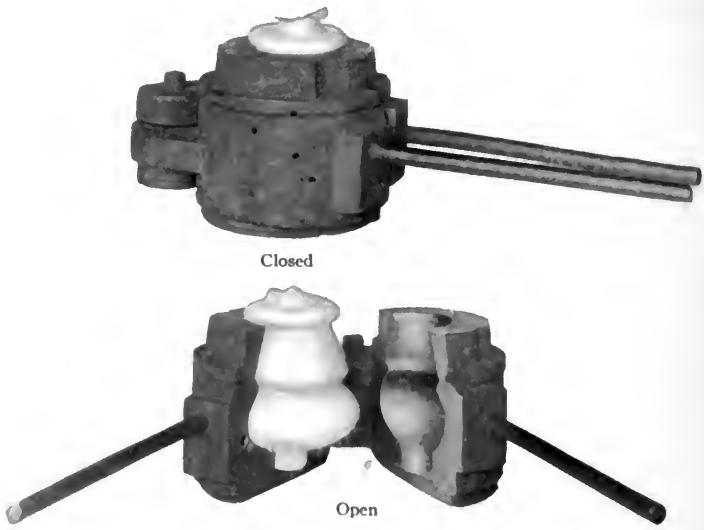
IN the manufacture of any article made from a liquid or molten substance, which is in its finished state either solid or shell-like, it is necessary to use some kind of form or mold which will give the finished article the desired shape. Each industry whose product is made in the most part by the aid of molds has its own peculiar type and trade names for molds.

Molds have been used in glass making from the very early ages. The ancient Egyptians used crude molds, presumably made of clay, in the manufacture of bottles and other containers and ornaments, upon the surface of which were sunken hieroglyphic characters. But the industry in those ages, in fact up to the time of the Venetians, was not developed commercially, and the use of molds probably died out or at least was not commercialized and improved. The Venetians made practically all of their glass by the off-hand method, which is accomplished without the aid of molds. Using this method the blower gathers the molten metal (glass) on the end of a tube and by blowing upon the tube, pressure is exerted upon the inside of the glass gathered. The blower, knowing exactly how much pressure to exert from the inside, combined with his skill in properly distributing the

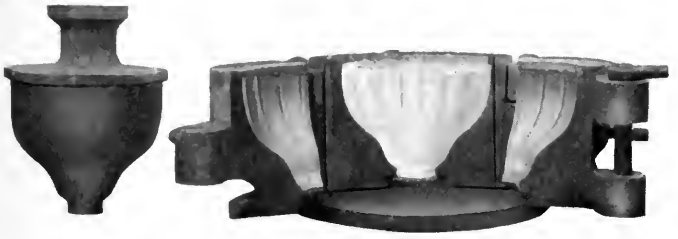
glass—by swinging or revolving the tube—and by the use of his various tools, is able to produce an article in the desired shape.

Glass molds are of three kinds: iron, paste and press molds, and considerable confusion has resulted from these names. The fact is that all of these molds are made of iron and the names which are used grew out of manufacturing methods rather than from the kind of material of which the molds are made. If one understands the history of glass making and the application of molds to help in the shaping of articles, he will understand better how the names of these different molds originated and will then be able to tell quickly which of the three styles has been used to make certain articles.

From the method used by the early Egyptians someone conceived the idea of an iron substitution for a primitive clay mold. These iron molds were



Paste Blow Mold



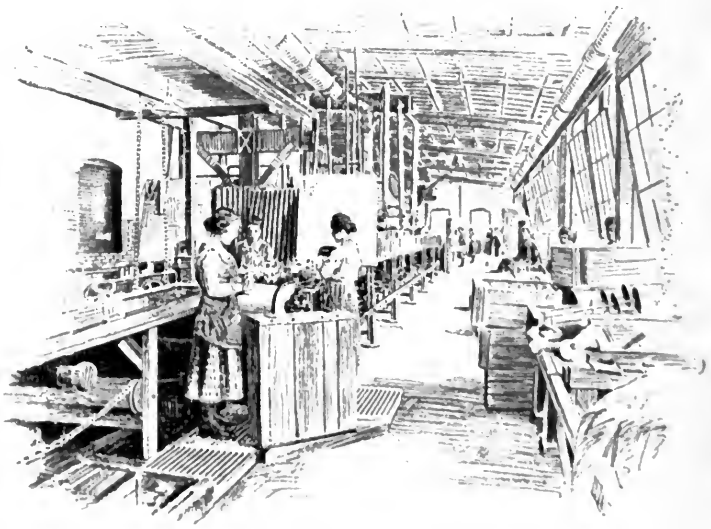
Press Mold Showing Plunger

made in two sections, hinged on one side and held closed by a clamp or lock on the opposite side. The inside of the mold was polished so that the surface of the finished article would not be marred or scratched. These molds consisted of two or more segments hinged together, which permitted the mold to be opened and the blown article removed.

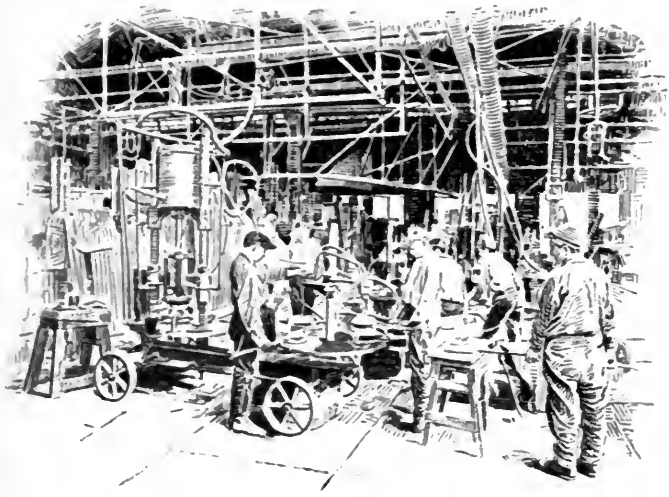
It was impossible to fit these molds tightly enough to prevent the mold joint or seam from showing on the surface of the finished articles in the form of a ridge. As the molds were cleaned from time to time and became abused in handling, the seam became more and more noticeable in every piece of glassware blown in them. This same condition exists today in spite of all modern methods of making tight joints—but of course to a much lesser degree.

Although the faces of these molds were highly polished, it was impossible to obtain a perfect surface and all inequalities that were in the iron showed in the glass. Of course the development of fine abrasives has enabled mold manufacturers to produce a much smoother surface; nevertheless, it is practically impossible to produce an iron blown article which does not have more or less of an obscure surface, varying of course with the condition of the mold.

The German glassmakers made molds from maple, apple and other hard woods which were kept water-soaked to prevent them from taking fire as soon as the molten glass came in contact with the mold. It was soon found that in spite of the water-soaked condition of the mold the extreme heat of the glass charred the surface of the mold and the longer it was used the larger became the inside dimension, consequently a larger article was produced than originally intended. It was also noticed that after a mold became slightly charred the blower could readily revolve the article which he was making. A study of these conditions revealed the fact that the charred surface of the mold formed a paste which acted as a lubricant, thus permitting the blower to turn the article at random. The finished article made in this way had a smooth surface free from seam marks and of a pleasing lustre.



Grinding and Polishing Tumblers



Semi-Automatic Machine

Iron molds were also in use at this time and it was found that if the inside surface of these iron molds was covered with some of this charred substance from the wooden molds the glass could be revolved, while being blown, just as it could in the wooden molds. From this developed a carbon mixture which is now known as "paste." This paste is applied to the inside of an iron mold and is frequently sprayed with water so that it will not get too hot and burn. The name "paste mold" is generally used to designate an iron mold which has an inner lining of some material which allows the glass to be turned or revolved while it is being blown.

It will be readily seen, however, that any article having a design or figuration impressed upon or raised from its surface cannot be revolved and must be blown in an iron mold. Any article having a smooth and

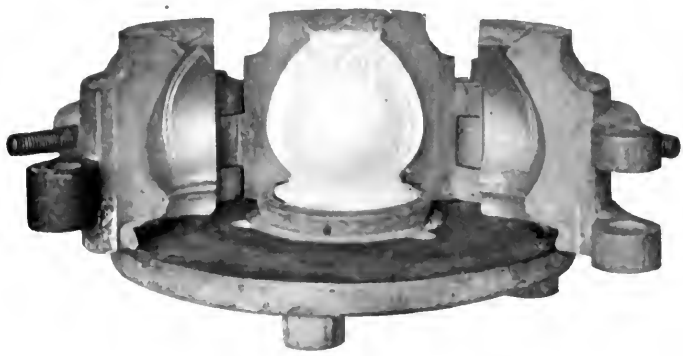
No. 832

symmetrical surface can be blown in a paste mold. Perhaps we can illustrate this better by two of our products, No. 832, which is a 12-inch paste mold ball globe, and our No. 2691, a 12-inch Alba ball globe with a figuration, which is made in an iron mold.

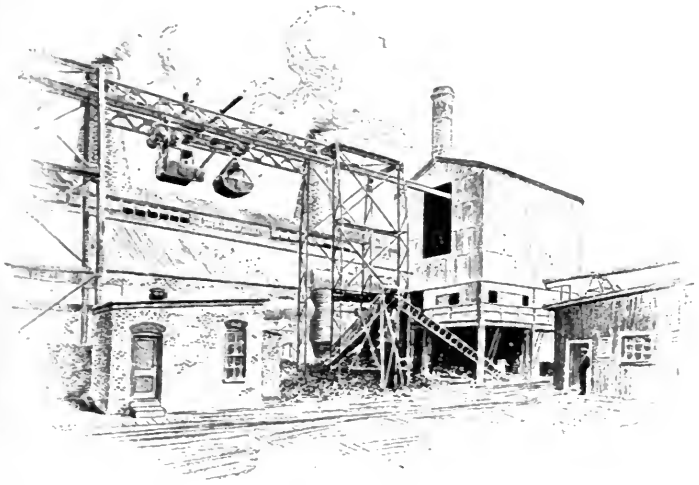
Lantern globes are blown in both paste and iron molds. Globes having lettering on their surfaces must be blown in an iron mold, but globes without lettering can be blown in a paste mold. The majority of lantern globes are, due to other manufacturing conditions, made by the iron mold process.

No. 2691

A press mold is made of iron and consists of two parts, the mold proper and the plunger. The mold proper forms the outside surface of the article and the plunger the inside surface. When they are in proper position the space between the surface



Iron Blow Mold



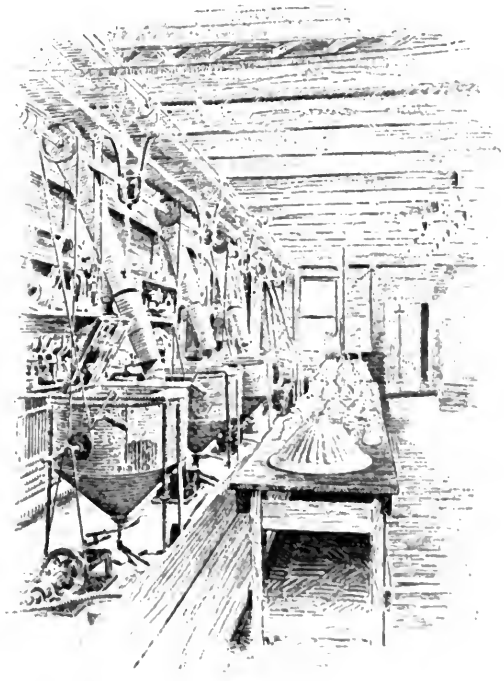
Part of Gas Producer Plant at the Charleroi Works

of the mold proper and the face of the plunger represents the article. The surfaces of both are very highly polished so as to leave as few marks as possible on the finished article. In making press mold glassware the molten glass is gathered on the end of an iron rod or punty and then dropped into the mold proper; the press operator severs with shears the intervening thread between the body of the glass and the punty. The plunger is now pressed down into the hot glass, squeezing it from the bottom of the mold up and around the sides until the mold is filled. One can readily see that the presser must know exactly how much glass to cut off the punty in order that the mold may be sufficiently filled when the plunger is dropped into place. Too much glass will cause over-pressing and too little under-pressing.

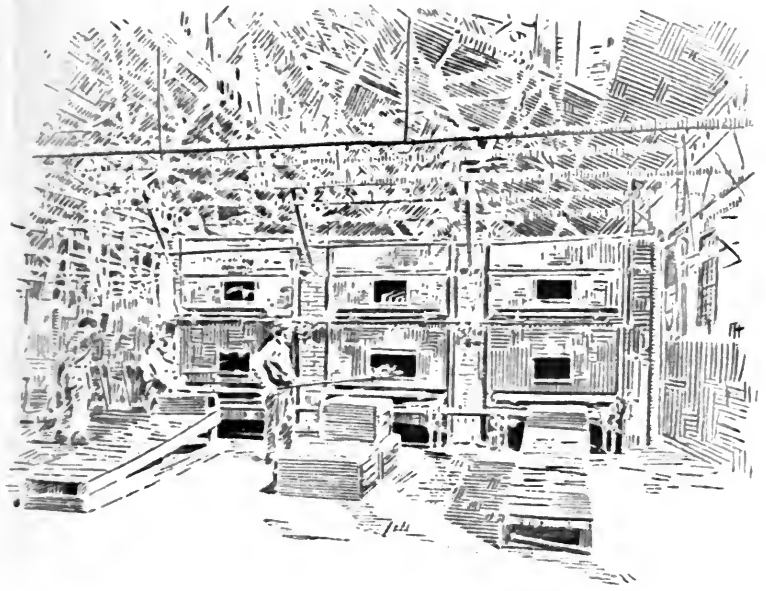
From the nature of the process it is obvious that in

making pressed articles the largest diameter is at the top of the mold, so that after the plunger enters the mold it may be withdrawn when the glass has solidified. Our Alba shades, such as No. 3429, are made in this manner, with the fitter at the bottom of the mold and the widest part at the top.

Glass cooled suddenly is fragile and will break easily when subjected to rapid temperature changes. The elimination of this brittleness is accomplished by tempering, or leering, as the process is called. After the glass has been blown or pressed into the proper shapes it is placed on large pans in a leer, which is an oven-like structure of considerable length with doors at both ends.



Sand Blasting Department



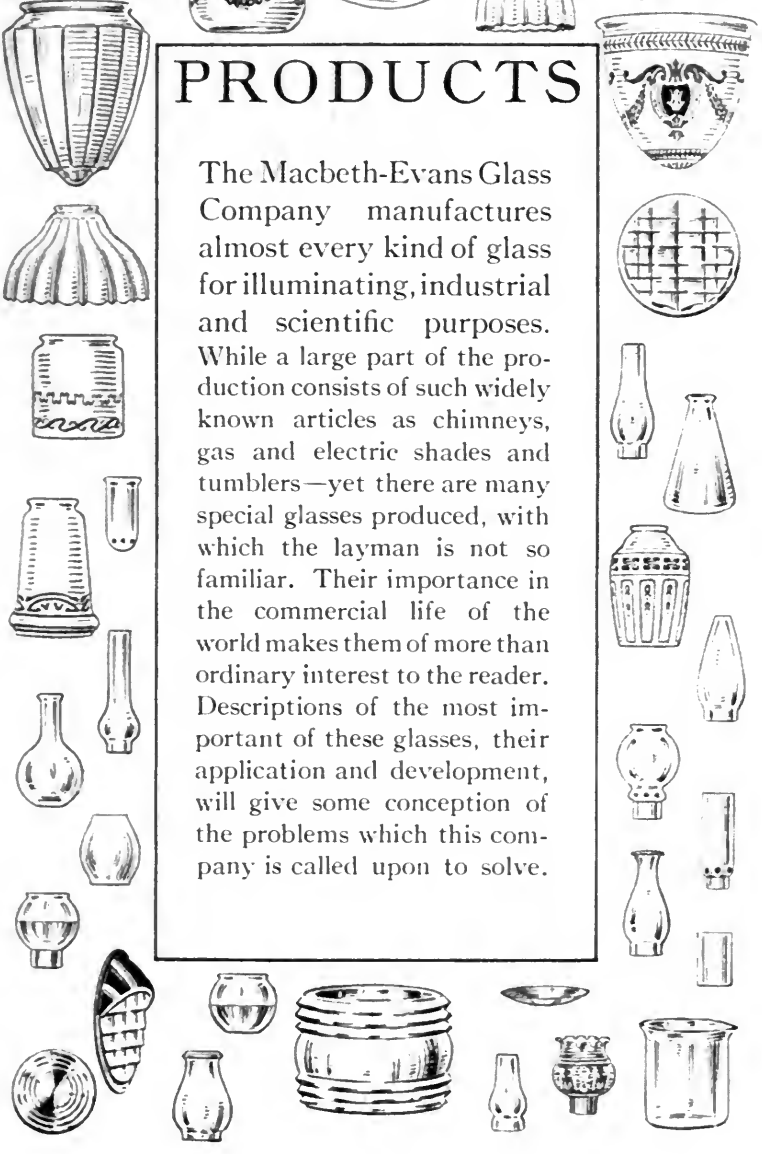
Leers

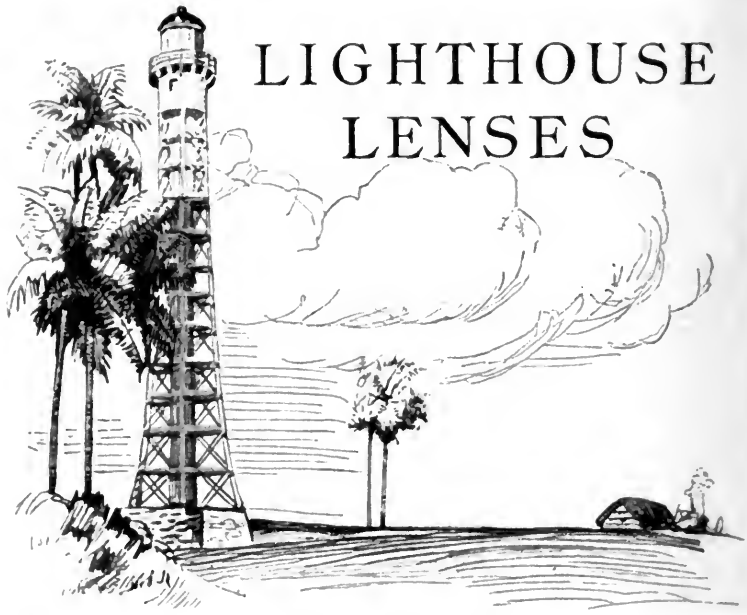
These pans are drawn by mechanical means through a zone of rising temperature which at its greatest intensity closely approaches the melting point of the glass. The pans move on into other zones, the temperature being gradually reduced as the glass approaches the end of the leer, from which it is removed. This slow cooling eliminates the brittleness that the glass would otherwise possess. Obviously, painstaking leering of glass is one of the essential elements in successful glass making.

THE WAR DEPARTMENT OF
THE UNITED STATES OF AMERICA
RECOGNIZES IN THIS AWARD FOR DISTINGUISHED SERVICE
THE LOYALTY ENERGY AND EFFICIENCY IN THE PERFORMANCE
OF THE WAR WORK BY WHICH
Macbeth-Evans Glass Company
AIDED MATERIALLY IN OBTAINING VICTORY FOR THE ARMS
OF THE UNITED STATES OF AMERICA IN THE WAR WITH
THE IMPERIAL GERMAN GOVERNMENT AND THE IMPERIAL
AND ROYAL AUSTRO-HUNGARIAN GOVERNMENT

PRODUCTS

The Macbeth-Evans Glass Company manufactures almost every kind of glass for illuminating, industrial and scientific purposes. While a large part of the production consists of such widely known articles as chimneys, gas and electric shades and tumblers—yet there are many special glasses produced, with which the layman is not so familiar. Their importance in the commercial life of the world makes them of more than ordinary interest to the reader. Descriptions of the most important of these glasses, their application and development, will give some conception of the problems which this company is called upon to solve.





LIGHTHOUSE LENSES

IN 1805 the great destruction of vessels with the consequent loss of life resulted in definite action the following year looking toward the systematic lighting of coasts and harbors. Previous to 1806 the coast signals at night were confined to a few "beacon" lights, produced by either coal or wood fires on tops of buildings erected for that purpose. This was an uncertain and dangerous method of marking coasts and harbors, as vessels could be lost by mistaking the fire of a lime kiln for a "beacon" light. The first permanent lighthouse was built about twelve miles distant from the coast of Scotland off the Firth of Forth. Here the great lighthouse engineer, Robert Stevenson, began experiments in which parabolic mirrors were used to project the light.

It was not until 1822 that Fresnel, an ingenious Frenchman, utilizing the experience of others, developed the cylindrical lamp employing one central light source. It is this system with improvements which is used today.

There is probably no more impressive example of the glassmaker's art than a lighthouse lens. Involved in its manufacture is not only a glass making problem but in addition a mathematical problem, an optical problem and a mechanical problem.

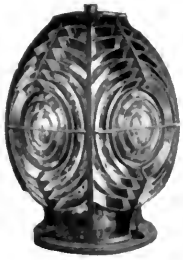
The making of lighthouse lenses by the Macbeth-Evans Glass Company for the first time in United States in 1910 was a signal triumph and convincing evidence of the great advancement of the art of glass making in this country. In this connection an extract from a paper read before the Engineering Society of Western Pennsylvania in 1914 by Mr. Macbeth is interesting:

"In commencing the manufacture of these glasses (Lighthouse Lenses) it seemed like assuming a duty with an unknown investment as well as an unknown loss or profit, but it also answered a challenge to an old glass center like Pittsburgh to produce high-grade articles and run the risk in the endeavor."

The first attempt to manufacture lighthouse lenses in the United States is best described in the annual report of the Secretary of Commerce and Labor, under which Bureau the Lighthouse Department operates:

"Until lately it has been necessary to procure all the cut glass lenses used in the Lighthouse Service from either France, England, or Germany, most of them coming from France. Recently the matter was taken up with an American firm of glass manu-

Fourth Order Six Panel Fixed Lens



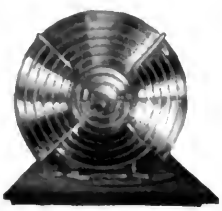
Fourth Order Four Panel Flashing Lens

facturers with a view to ascertaining if a better lens could be made in this country than abroad by using some modern manufacturing methods. The results to date have proven satisfactory. The lenses are superior to those purchased abroad and can be made for the same cost or less. The essential feature of the American method of manufacture is that the prisms are formed by machine instead of by hand. Every part is made to fit an accurate template or jig, so that they are true to size and parts of the same number are completely interchangeable. Improvements have been made in pressed glass lens lantern and buoy lantern lenses, and tests show them well adapted for many conditions of the service, at a decrease in expense."

Due to superiority of design and the accuracy attained in manufacture, the lighthouse lenses made by the Macbeth-Evans Glass Company are approximately fifty per cent more efficient than those made abroad. The glass which is used is not hygroscopic—that is, it does not absorb moisture. Because of this fact, Macbeth-Evans lighthouse lenses, after years of continuous service, have the same clear, highly polished appearance as when originally installed.

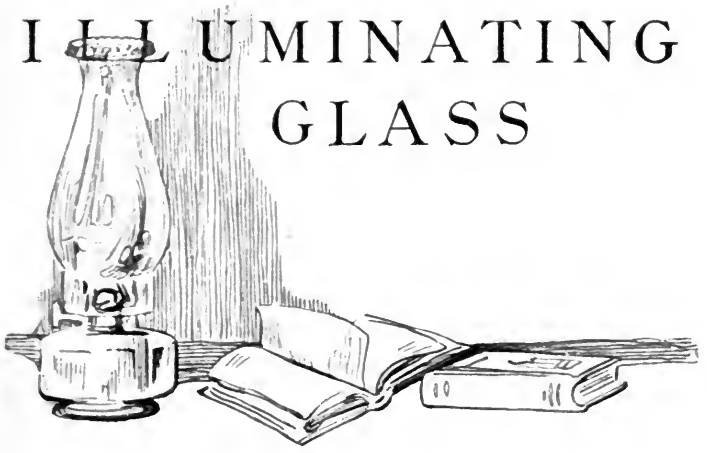
300 MM Fixed Lens

This "permanent" glass, as it is sometimes called, made by this company, is the result of extensive research which culminated in producing the proper combinations of certain materials which form the glass batch. The actual melting of the batch and the manipulation of the glass are, obviously, vital parts of the whole process of securing successful results.



Fourth Order Two Panel Bivalve Lens

ILLUMINATING GLASS



IN Pennsylvania in 1859 Col. E. L. Drake, successfully boring for petroleum, caused the flooding of the market with oil at prices never dreamed possible. This led to the introduction of foreign-made oil lamps and had the immediate effect of stimulating their manufacture in America. Chimneys being an essential part of oil lamps, it was quite natural that the increased use of the latter would cause a correspondingly heavy demand for the former. It was not long before the consumption of chimneys became so great that their manufacture quickly grew into a distinct industry in Pittsburgh.

It was as manufacturers of lamp chimneys that Geo. A. Macbeth and Thos. Evans became identified with the glass industry. Although many diversified lines for widely different purposes are now made by the Macbeth-Evans Glass Company, yet the major part of the production is illuminating glass.

The fame of "Pearl Glass" and "Pearl Top" lamp chimneys has extended to the most remote parts of the globe. They continue to be sold where oil lamps are burnt and, strange to relate, there is a surprisingly large number of lamp chimneys used today—this in spite of the development of the more efficient modern light sources.

The advent of the Welsbach mantle in 1886 created a demand for illuminating glass of somewhat different character than that used for oil lamps. The manufacture of chimneys, shades and globes for this new light source made necessary new factory equipment and the readjustment of the business to meet the changed conditions.

The incandescent electric lamp, possibly the most interesting development in illumination, was the achievement of the famous American, Thomas A. Edison. Electric lighting had been used previous to Edison's invention but was produced by the means of the electric arc, discovered by Sir Humphry Davy in 1801. The greatest development in the use of electricity for lighting has been during the past twenty-five years. Special glassware was devised by this company to meet the requirements of each improvement in electric lighting.

Commercial Lighting Unit

It is interesting to note that the Macbeth-Evans Glass Company has contributed through its illuminating engineering department and by extensive publicity in no small degree to the impetus which has been given ornamental street lighting during recent

years. Handsome posts, surmounted by attractive and efficient globes made either of Alba or Monax Glass, are enhancing the appearance of cities and towns today.

The manufacture of illuminating glass for the carbon filament lamp, and more recently for tungsten and gas filled lamps, has given the resources of Macbeth-Evans Glass Company an opportunity for real expression.

This company recognized early in the development of modern light sources that their intrinsic brilliancy required modification in order to produce useful and efficient illumination. The invention of Alba—a white diffusing glass—was the first step toward the solution of the problem. The manufacture of this glass in the form of globes, shades and bowls, scientifically designed to distribute the light efficiently, quickly followed its invention.

In the creation of an illuminating engineering department, the facilities, which this company offered to those who desired efficient as well as attractive illumination, were complete.

Comprehensive publicity campaigns, advocating better lighting, had the effect of creating a demand for improved lighting conditions in factories and offices, as well as in homes. The requirements of home lighting differ somewhat from the demands of the industrial world. It is the desire of the average owner to light his home artistically, depending upon local illumination for reading or writing. It was therefore with this in mind that the illuminating glass manufactured by this company for residence lighting was designed.

Alba, in many of its decorative forms, has been used to advantage in home illumination.

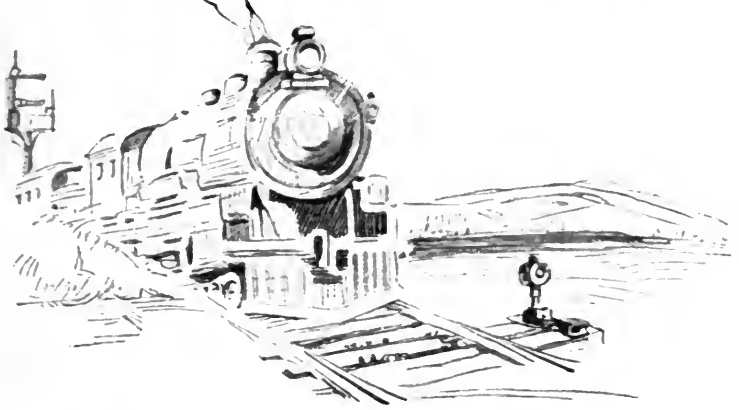
Street Lighting Post

Thebian is another form of decorated glass designed to meet the requirements of those residences in which artistic lighting is desired at moderate cost. Artistically, however, the most beautiful product of the Macbeth-Evans Glass Company is the glass known as Decora. Here the artist designer was given the opportunity for unlimited expression. Exquisite colors combined with a wealth of rarely decorative designs distinguish Decora among other illuminating glass. It is truly a glass of character—distinctive because of its originality and artistry, yet having the restraint necessary to become part of an harmonious interior.

The illuminating glass made by this company includes not only that described above, but in addition a great variety of more or less staple shades and globes in common use, the description of which would be uninteresting because it is so well known.

Semi-Indirect Lighting Unit

RAILWAY GLASS



THERE is probably no more exacting consumers of glass than the railroads. It is important to the traveling public that such be the case, as glass is a vital part of all railway signal systems. The large American railroads maintain testing departments, which scientifically examine samples of all railway guide glass. For instance, photometric tests are made when color and transmission of light are involved, and when it is necessary that the glass have a certain inherent strength, it must pass mechanical shock tests. These tests determine whether or not the glass will meet the rigid specifications of the Railway Signal Association.

It is interesting to know that red and yellow glasses transmit approximately one-fourth as much light as clear glass—green glass one-sixth and blue even less. In order, therefore, to project red light rays as far as white, the intensity of the light source must be four times that used with clear glass, while for green it must be six

Roundel

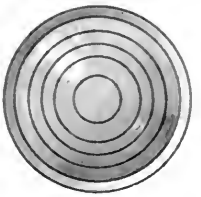
times as great. In small detached units it is not practicable to so grade the light sources, and for this reason the railroads require colored glass which has a minimum of absorption. This is one of the many problems which must be solved by the Research Department of this company. Another is to make a glass which when subjected to mechanical shock sufficient to break it will not fall to pieces. The importance of this quality is best illustrated when we consider the situation of the flagman, who may break the red globe in his lantern when going out in a storm to stop a train. Disintegration of a globe could easily result in a serious accident, such as a rear-end collision.

In the manufacture of roundels, which are used in connection with semaphore signals, the color of the glass is the essential requirement. Lantern globes, other than clear, on the other hand, must combine, not only the quality of great heat resistance necessary in clear globes, but also the proper colors to meet rigid railroad specifications. Lamp chimneys for switch lamps and coach lighting must also be made of special glass.

One of the outstanding developments in the making of glass for railroads was accomplished in producing tubular and reflex water gauge glasses now used on locomotives. Previous to the invention of the special glass now used in their manufacture serious accidents resulted from the breaking and disintegration of gauge glasses, allowing the escape of scald-

R. R. Lantern Globe

ing steam and hot water. The inherent construction of the gauge glasses now made for railroads by this company is such that if a gauge glass is broken, it does not disintegrate and preserves its original shape, thus preventing the escape of steam from the boiler.

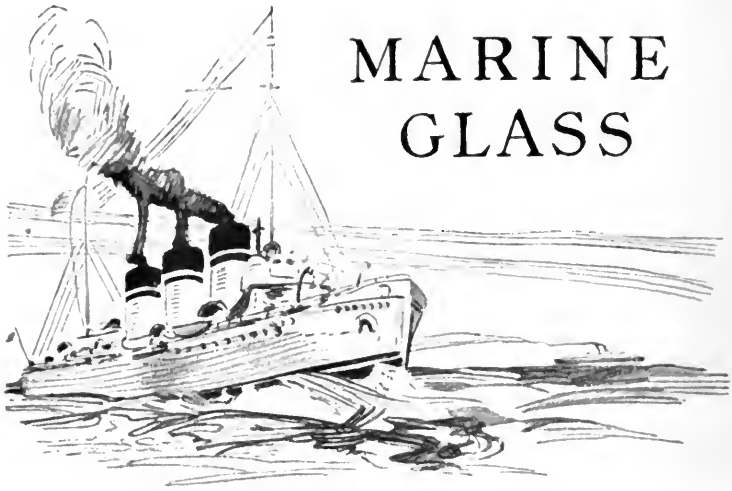


Semaphore

The automatic signals of railroads are dependent for their operation upon electric storage batteries. One can easily imagine the serious consequence should these batteries fail to operate. It is of vital importance therefore that the glass jars used to encase batteries be so made that they will withstand the most severe service. On some of the Northern roads it is not uncommon to renew batteries by pouring in caustic soda, thus bringing the temperature inside of the glass jar up as high as that of boiling water when the temperature outside the jar may be below zero. To determine whether the Macbeth-Evans battery jars would stand this terrific strain samples were placed in cracked ice, where they were allowed to remain until the temperature of the glass had been reduced to 5° F when boiling water was poured into the jar. This is a severe test but is necessary because of conditions under which battery jars are used.

Gauge Glass

The illumination of coaches, Pullman cars and terminals has in recent years been given more consideration by the railroads than formerly. This company manufactures specially designed shades and globes made to meet certain photometric requirements specified by the railroads in order to secure efficient lighting of terminals and cars for passenger service.



MARINE GLASS

TO those who have spent their lives on land the statement that a vessel could not safely leave our shores without being equipped with certain glasses may seem somewhat exaggerated.

It is quickly apparent even to those least familiar with the sea that a ship would be in constant danger traversing the ocean at night without masthead, port, and starboard lights, running lights as they are called. These lights are of different colors, thus identifying certain parts of the vessel. It is for these lights that this company makes special glass to meet marine conditions.

Gauge glasses like those used on the railroads are provided for the high powered steam boilers with which the large passenger liners and warships are equipped. These gauge glasses must resist the corroding

action of superheated water under steam pressure. The superiority of gauge glasses made by this company is shown by their widespread use by the United States Government, as well as by private steamship companies.

During the recent war the Macbeth-Evans Glass Company devoted almost all of its production to the manufacture of glass for the army and navy. Chief among the articles made were the reflectors used on the powerful searchlights with which our warships and coast defenses are equipped. A battleship's battery of searchlights is a vital part of its equipment. In repelling a night attack it is obviously desirable that a ship have sufficient searchlights to disclose each attacking unit; the lack of an additional searchlight might mean a battleship's doom, since one of the small, swift-attacking units may slip up and deal the great ship its death blow under cover of darkness.

Mirrors for searchlight purposes are of varied forms and sizes, the shape depending largely upon the particular form of beam which they are designed to project. Large searchlights generally are designed to project a straight beam or bundle of light, and for this purpose a reflector having a parabolic form is required.

In most cases these parabolic mirrors are made of crystal mirror glass. A flat disc of the glass is placed in an oven on a parabolic iron former. The temperature of the oven is increased gradually until the glass softens sufficiently to settle down to the shape of the former.

This approximately parabolic blank is then ground to a true curvature on both the inside and outside surfaces. After polishing and silvering, the mirror is subjected to severe test to determine whether the various zones of the inside and outside surfaces have a common focus. After completion each lens is rigidly examined by a government inspector.

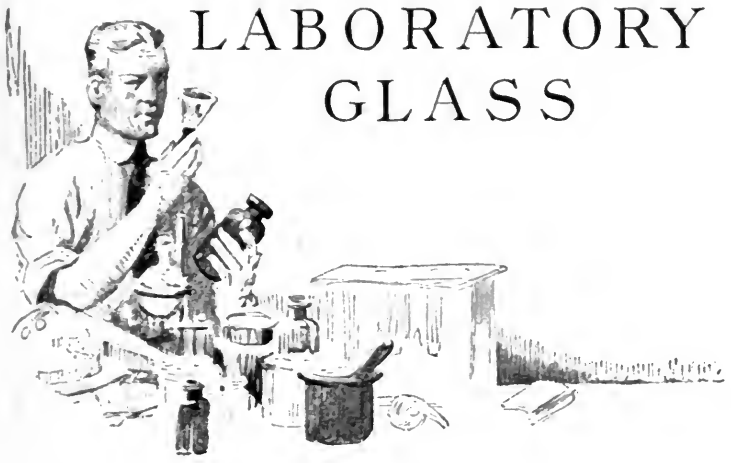
The glass itself must be of good color and free from cords, seeds, etc. It must also show durability under the action of atmospheric agents.

Aside from the constitution of the glass itself the backing or silvering presents a difficult problem; the nature and quality of the glass considerably affects the ease and success of the various silvering processes.

Many of the older mirrors have mercury or quicksilver films placed on their reverse surface for the reflecting medium. Generally speaking, the present method is to deposit metallic silver upon the glass, but the manner in which this is accomplished, to enable the mirror to stand up under government tests, is a trade secret with the manufacturer. The silvering must be deposited at a rate that can be controlled and in a manner to give a uniform, continuous film, free from all defects.

There are other glasses used on board ship which are essential, the description of which is impossible here because space is limited.

LABORATORY GLASS

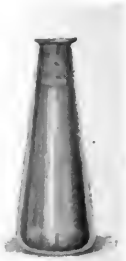


THE increase in the number of industrial laboratories throughout the country during the past few years has caused a heavy demand for laboratory glass. In addition there is a large consumption of this kind of glass by private testing laboratories, schools and colleges.

In order to realize the difficulties that present themselves to the glass manufacturer in the production of high quality glass for chemical purposes one should know that when the science of chemistry was still in its infancy chemists generally had not yet realized the necessity of having glassware of known resistance to repeated evaporation and resistance to chemical reagents.

When water was boiled for considerable period in glass ves-

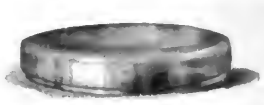
sels a distinct amount of solid matter collected in the glass container. The explanation commonly given, on the basis of the old Greek philosophy, was that water had been turned into earth.



Lavoisier, the great French chemist, came into contact with this problem in his earlier experiments, and was not satisfied with this explanation. He was soon able to prove that the earthy matter observed was accounted for by the attack of the water on the glass, which had corroded or lost weight during the boiling process.

Davy, another of the early chemists of note, in his electro-chemical experiments, was able to show that the alkaline substances found in water that had been boiled in glass containers could only have arisen from the glass used as the containing vessel. As the developments of quantitative chemistry proceeded, other errors in analytical work were noted which arose through the use of the glass apparatus of the day.

Because of this chemical instability of glass surfaces there soon arose a demand for a glass that would resist the action of solutions that might be placed in it, but years of experiment were to pass before it became commercially possible to produce such a glass. Eventually, however, the desired results were achieved, and a satisfactory glass was produced, thus making it possible for the chemist to accurately determine the atomic weights of various substances.



The chemical processes involved in determining atomic

weights constitute a delicate task. The substance must be first prepared and weighed in the pure state, and must then be subjected to suitable reactions and again weighed with proof that in the process nothing has been lost and nothing accidentally garnered into the material to be placed on the scales. These requirements among other things require a glass the production of which is a technical problem of the first rank, and even today considerable variation is still to be found in the various makes of laboratory ware.

This company produces a glass which is eminently suitable for analytical work, since it gives up no appreciable quantity of alkali even after prolonged boiling. This glass resists not only gradual heating, which almost any glass will stand, but also violent and sudden changes of temperature —in other words having a low coefficient of expansion. Alkalies and acids have a negligible effect upon it.

MISCELLANEOUS GLASS

IN addition to the glasses which have been described there are many other kinds for special purposes, made by this company, which cannot be placed under broad classifications. A few of these are sufficiently interesting and important to warrant their mention here.

The glass condenser jars used in connection with the more powerful types of wireless sending apparatus are made of a special glass, which will withstand the tremendous shock of electrical currents from high frequency. This is an unusual glass, the successful making of which was not dreamed of a few years ago.

An American company utilizing large vats for distilling purposes was in a quandary a few years ago because of frequent replacements of the observation glass through which the contents of the vat are observed. The glass which was used lasted but a few days, because of its inability to resist a chemical action of the contents, sudden changes of temperature, and corroding action which caused the glass to become obscured. To meet these unusual and severe conditions this company invented a glass which resists not only the chemical

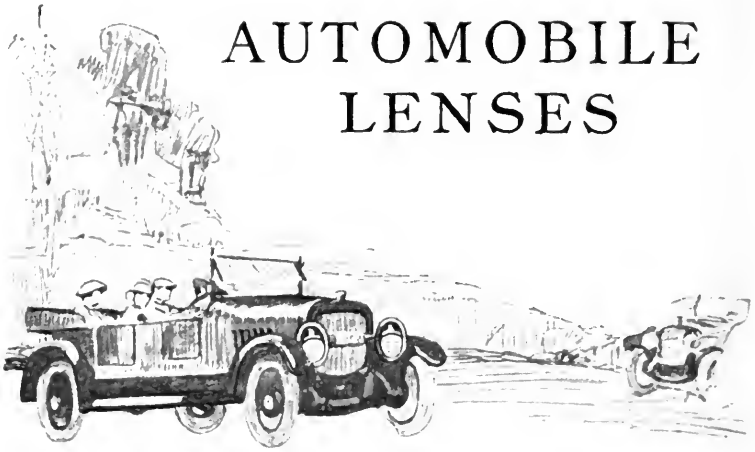
Condenser Jar

action of the contents of the vat, but in addition will not break when subjected to sudden changes of temperature. The use of the special glass has resulted in reducing the cost of production through the fact that it is now possible to keep the vats in operation almost continuously.

In coal mines, where electric lights are not used, accidents have occurred due to defects in the glasses used in miners' safety lamps. A miners' safety lamp glass has been produced by this company which will not fall to pieces, or even permit the passage of air through a crack in this glass. The introduction of this glass has no doubt averted many mining catastrophes that have so often in the past formed terrible blots upon the pages of the history of coal mining.

Flame Test
Miners' Safety Lamp Glass
Flame can play indefinitely against glass without breaking it

AUTOMOBILE LENSES



THE alarming increase in the number of automobile accidents in the United States caused by glaring automobile headlights definitely established the necessity for this light to be controlled in a way to eliminate dangerous glare and to provide at the same time the long range and side lighting necessary for safe driving.

The engineering skill which produced the wonderful lighthouse lenses made by this company was concentrated on the problem with the result that "Macbeth Green Visor" and "Liberty" lenses are giving the same measure of safety to motorists as Macbeth lighthouse lenses are giving to travelers upon the ocean and inland waters. More than 1,000,000 automobiles are now equipped with headlight lenses made by the Macbeth-Evans Glass Company.

Macbeth Lens

Liberty Lens

List of Products

THE following is a list of articles made by this company, reproduced to give a general idea of the ramification of glass making. It will also serve to acquaint the reader with the reason why 80% of the production of the Macbeth-Evans Glass Company went to the government during the recent war.

July 14, 1918, Commodore Denig gave the command to break out the Emergency Fleet Flag at the Charleroi Works. This date to future generations will be a reminder that the 264 employees of the Macbeth-Evans Glass Company who served in Army and Navy, and those who remained at essential tasks at home, contributed in no small way to bring the war to a successful conclusion.

Flag Raising, July 14, 1918

Lamp Chimneys for domestic use.
Lamp Chimneys for railroads.
Lamp Chimneys for lighthouses.
Lamp Chimneys for steamships.
Lamp Chimneys for street lighting.
Lamp Chimneys for gas mantle burners.
Lantern Globes.
Lantern Globes for use as signals on railroads.
Lighting Fixture Glassware.
Globes for street lighting.
Shades for street lighting.
Reflectors for street lighting.
Globes for Welsbach and other gas mantle burners.
Shades for Welsbach and other gas mantle burners.
Laboratory Glassware.
Tumblers.
Lubricator Glasses—used on gas and steam stationary engines, locomotives and steamships.
Miners' Glasses—used in miners' safety lamps in all gaseous mines.
Gauge Glasses, flat (oblong and round)—used on all steam gauges on stationary boilers, locomotives, and by the Navy on nearly all war vessels.
Gauge Glasses, tubular—used on all steam gauges on stationary boilers, locomotives, and by the Navy on nearly all war vessels.
Protector Glasses—used on tubular gauges, on stationary boilers, on locomotives, and by the Navy to protect firemen and engineers from escaping steam caused by the breaking of tubular gauge glasses.
Observation Glasses—used in the manufacture of chemicals.
Glass Sponge Cups for holding sponges for office use.
Reflectors for automobile and truck headlights.
Reflectors for household use in connection with old-fashioned wall brackets.

Shades for railroad use.
Founts for side wall brackets for household use.
Bowls for use in railroad cars.
Plates for use in stove doors.
Meter Covers for gas meters.
Dental Glassware for spittoons in dental chairs.
Globes for collection boxes.
Globes used in flour mills.
Globes for electric sign use.
Globes for water filters.
Globes for sterilizers.
Cylinders for carburetors on automobiles and trucks.
Cylinders for electric meters.
Globes for ship lights and in tunnels.
Bowls for ship lights.
Cylinders for airplanes.
Lenses, in colors, for airplanes.
Cups to collect oil drippings in lamps used in railroad coaches.
Bull's-eyes for advertising signs.
Bull's-eyes for lanterns.
Globes used as containers in dispensing gasoline.
Candle Globes for ecclesiastical use.
Bottles for milk testing.
Glass bowls for automobile lighting.
Glasses for dispensing paper cups.
Lenses for lightships.
Mirrors for searchlights for the Army and the Navy.
Ship Light Glasses—used on vessels—masthead, port, starboard and running lights.
Buoy Light Glasses—used on buoys for marking channels along coast.
Lenses for lighthouses.
Lenses for automobiles, trucks and motorcycles.
Lenses for railroad signals.

Lenses for locomotive headlight use.

Battery Jars, of special quality of heat-resisting glass, for the operation of block signals on nearly all United States Railroads and in Europe.

Relay Covers for covering apparatus for operating signals on railroads and water meters.

Glazing Glasses for polishing leather.

Globes for Pintsch and other railroad passenger car lighting systems.

Cab Globes for illuminating locomotive gauges.

Candle Globes for railroad passenger cars and cabooses.

Lamp Chimneys for locomotive headlight and passenger car use.

Headlight Front Glasses, of special quality glass, for locomotive headlights.

Elevator Signal Glasses.

Vacuum Bottles for Thermos and other vacuum bottles.

Mantle Formers—used in the manufacture of gas mantles.

Glasses for coffee percolators.

Glasses for vending machines.

Glass Bushings for bell cords and whistle cords in railroad coaches.

Globes used in chemical manufacture.

Globes for medicinal use.

Tubes for Ozone machines.

Globes for water heaters.

Jars to contain tobacco.

Plates for dental chairs.

Holders for cotton for dental chairs.

Glasses for automatic milking machines.

Toward Tomorrow

THERE are comparatively few prosperous businesses a half century old. This will not seem astonishing when we consider that our country is still young in the world's history. The pardonable pride of the Macbeth-Evans organization, because of its long and successful career, is tempered by the responsibilities thrust upon those whose duty it is to maintain the carefully fashioned individuality which has distinguished the Macbeth-Evans Glass Company since its founding. The personnel changes, but those intangible but nevertheless potential forces—the spirit and ideals of the founders, together with the traditions of the company—remain to mark the course for those upon whom rests the responsibility of preserving Macbeth-Evans standards.

In the growth of the Macbeth-Evans Glass Company the value of knowledge gained by intimate contact with the intricate problems of the business has been carefully emphasized. It is this tradition which has made possible many of the achievements of glass making recorded in the preceding pages.

The earliest effort produced an incomparable lamp chimney. The same high standards of progressive manufacturing gave to the world at a later date Alba, the original white diffusing glass. It is seemingly a far cry from a modest lamp chimney to that marvel of the glassmakers' art, the lighthouse lens, yet the successful manufacture, for the first time in the United States, of lighthouse lenses, by this company, was a natural development, a visible tribute to the fifty-year tested ideals and policies of the Macbeth-Evans organization.

It is in the contemplation of a successful past that we find the best augury for a successful future.

We are indebted to the Pennsylvania Museum of Philadelphia for their courtesy in allowing us to use the following illustrations found on pages 19, 20 and 21: Glass Beads made at Jamestown, Va., 1621-1625; Stiegel Glass Tumbler and Molded Bottle, Early Nineteenth Century, and to the Carnegie Library of Pittsburgh, Pa., for several illustrations in the Historical Section.

With profound sorrow we announce the death of

Mr. Thomas Evans

President and one of the founders of this Company

on Saturday, the eighth day of December

nineteen hundred and twenty three

Macbeth-Evans Glass Company

Pittsburgh, Pa.

TP
853
P6M3

Macbeth-Evans Glass Company,
Pittsburgh, Pa.
Fifty years of glass
making

Engin.